SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1914.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1914.

GENERAL PHYSICS.

796. *A New Piston Air-pump.* **W. Gaede.** (Phys. Zeitschr. 14. pp. 1238–1240, Dec. 1, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—The new air-pump consists of four air-pumps vertically one above the other, worked by the same piston rod and enclosed in the same cylinder. Water-vapour is not got rid of by means of deliquescent substances, but by means of a special tissue through which the air passes. The vacuum can be brought to 0·00005 mm. within a few minutes. E. E. F.

797. *Electrical Measuring Machine.* **P. E. Shaw.** (Inst. Mech. Engin., Proc. 2. pp. 579–625; Communications, pp. 625–629, March–April, 1913. Elect. Rev. 73. p. 127, July 25, 1913. Electrician, 72. pp. 9–11, Oct. 10, 1913. Abstract.)—The author summarises the results of his paper as follows:—

(1) A new measuring machine is described founded on the principle of electric touch [see Abstracts Nos. 1116 (1906), 718 (1911)]. It is applicable to the measurement of regular solid bodies, *e.g.* cylindrical, spherical, or parallel-faced, whether metallic or non-metallic. The present machine embodies improvements found desirable in the earlier machine. (2) The solid to be measured is firmly held in a clamp. It can be adjusted in azimuth and elevation and so set parallel to the line of measurement. It can also be run into position by movements perpendicular to its length. For comparison, two solids can be clamped side by side. (3) The unit of measurement is $0{\cdot}1\mu$ ($=\frac{1}{10000}$ mm.), and comparative readings can be relied on to this amount. (4) The actual length of a solid as compared with a line-standard can be obtained. (5) The parts of the machine directly involved in the measuring are susceptible of adjustment; and the errors arising in taking measurements can be estimated. (6) The machine has been chiefly used for testing and measuring engineering gauges. The Johansson gauges are so regular in figure that the usual measuring machine cannot detect any irregularity in them. With the present machine, errors of the order $0{\cdot}2\ \mu$ can be proved to exist. L. H. W.

798. *Viscosity of Undercooled Water.* **G. F. White** and **R. H. Twining.** (Amer. Chem. Journ. 50. pp. 380–389, Dec., 1913.)—A new viscometer is described which is specially adapted to measure the viscosity of a liquid over a wide range of values. The time of flow both upwards and downwards under a given pressure is measured, thus eliminating some of the usual corrections. The values for the viscosity of water from 0 to 20° differ only by 0·00003, or 1 part in 400 from those given by Bingham and White. At and below 0° the values are—

0°	−2·10°	−4·70°	−6·20°	−7·28°	−8·48°	−9·30°
0·01798	0·01880	0·02121	0·02250	0·02341	0·02458	0·02549

T. M. L.

799. *Thermal Coefficient of Micrometer Screw.* **G. Bigourdan.** (Comptes Rendus, 158. pp. 219–220, Jan. 22, 1914.)—The ordinary method of determining the temperature variation of a micrometer screw on an astronomical instrument is to measure the difference of declination of two conveniently situated stars with the same instrument in winter and summer. Some uncertainty is introduced in the exact focusing of the star image, and the author proposes to use the delicate focusing device described recently by Lippmann [Abstract No. 640 (1914)]. When this is done it will then only be necessary (1) to measure the linear value of one turn of the screw, and the coefficient of its expansion; (2) to measure the variation of focus of the objective with temperature, with reference to the tube holding it. C. P. B.

800. *Calibration of Repsold Meridian Circle.* **P. Harzer, H. Kobold,** and **O. Tetens.** (Zeitschr. Instrumentenk. 34. pp. 20–23, Jan., 1914.)—Notes of tests made on the calibration of the divisions on the limb of a Repsold meridian circle. A summary is given showing the variations at various positions. C. P. B.

801. *Use of Spring Manometers in the Measurement of Large Forces in Testing.* **A. Martens.** (Zeitschr. Vereines Deutsch. Ing. 58. pp. 201–206, Feb. 7, and pp. 303–307, Feb. 21, 1914.)—As a result of continued observation the author has arrived at the conclusion that if the precautions mentioned in the original are observed the spring manometer is a perfectly reliable apparatus for the measurement of water pressure in testing machines and can be employed alone, without any weights, for the determination of the force exerted in testing machines, thus permitting of a considerable simplification in the construction. L. H. W.

802. *Note on the Setting of a Mercury Surface to a Required Height.* **M. H. Stillman.** (Bureau of Standards, Bull. 10. Reprint No. 214. pp. 3–6, 1914.)—The method described is designed for use with Fortin barometers and in other cases where it is desired to set a mercury surface accurately to a level which is indicated by a pointer projecting vertically downwards from above. A scale ruled with parallel horizontal lines is fixed in a vertical plane immediately behind the mercury so that the reflection of the lines is seen in the surface. As soon as the pointer touches the surface the resulting "dimple" is indicated in a pronounced manner by the distortion of the reflected lines. The average variation in the setting of the surface can be reduced by adopting this device to about one-tenth of its value under the ordinary method. J. S. Di.

803. *The Testing of Barometers at the U.S. Bureau of Standards.* (Bureau of Standards, Circular No. 46. pp. 8–12, 1914.)—Describes the tests which are carried out by the Bureau. Useful general information is given as to errors and their avoidance. L. H. W.

804. *Technique of High-pressure Experimenting.* **P. W. Bridgman.** (Amer. Acad., Proc. 49. pp. 627–643, Feb., 1914.)—Presents the results of several years' experience in designing and using high-pressure apparatus (12,000 to 30,000 kg./cm.^{2}). The following parts are dealt with in detail :—Packing of piston, actuating of piston, cylinders, connecting pipes, pressure gauges, valves, and plugs. [See Abstract No. 1304 (1913).] H. S. R.

805. *Causes of Error in Shock Tests and the Idea of Brittleness.* **A. Mimey.** (Rev. de Métallurgie, 10. pp. 1239–1256, Nov., 1913.)—The subject is discussed at some length, with examples, but does not lend itself to brief treatment. L. H. W.

806. *New Compensation Methods and Thermal Adjustment.* **J. Andrade.** (Comptes Rendus, 158. pp. 471–473, Feb. 16, 1914.)—The author discusses three methods for avoiding the use of the open flexible ring hitherto employed for compensation purposes, since Phillips has shown that even in a single vibration of the balance of a marine chronometer a strong disturbance of isochronism is set up. This is an extension of previous work on the regularity of action of spiral systems, and Guillaume has succeeded, in the case of pocket watches, in using a rigid balance in association with a compensation spiral. If, for example, a system of palladium spirals be used, whose secondary error is negligible, the elastic loss must be compensated, as this is appreciably greater than the simple thermal expansion, and a compensating mass must be introduced for this purpose. The latter forms the basis of all three methods. The first employs two metals in contact of different dilatability, the second involves the use of mercury reservoirs on two or four of the balance-arms, and the third utilises a cone and spring system which operates as a lever carrying the compensating mass. The two former methods are recommended by the author for practical purposes. H. H. Ho.

807. *Work of the Royal Depôt for Testing Materials* (*Materialprüfungsamt*) *for* **1912.** (Königl. Materialprüfungsamt, Mitt. 31. 5. and 6. pp. 221–286, 1913.) —The information given covers the whole range of subjects investigated. It is possible here only to refer to a few of the more interesting results obtained in the testing of metals. Thus for cast iron the test should always be carried out according to the methods proposed by the German Association for Testing Materials, according to which cast circular rods 30 mm. in diam. and 650 mm. in length are to be used, supported at points 600 mm. apart and loaded in the middle, the breaking load and deflection at rupture being determined. These trials are supplemented in two cases by tension and compression tests on the broken halves of the test-piece. The following values were found :—

Strength in bending test	$\sigma_B = 4170$ and	2830 kg./cm.^{2}.
Deflection....................................	$\delta = 0{\cdot}98$ „	0·9 cm.
Tensile strength	$\sigma_B = 2140$ „	1410 kg./cm.^{2}.
Elongation	$\delta = 0{\cdot}5$ „	0·4 %.
Strength in compression	$\sigma_B = 9000$ kg./cm.^{2}.	

The coefficient of expansion was determined for 5 sorts of cast iron at various temperatures. No difference was observed between the different sorts, the mean values being :—

20° to 75° C. : $0·0000107_6$
75° to 150° C. : $0·0000118_9$
150° to 200° C. : $0·0000119_7$
200° to 250° C. : $0·0000126_4$

Tests were made on glass and on porcelain cubes of 10 cm. side. The glass cubes showed a mean strength of 747 kg./cm.^{2}, a somewhat higher value being obtained after exposure to frost (— 14° C.). Porcelain, on the other hand, showed 1590 kg./cm.^{2} at room temperature and only 1106 kg./cm.^{2} when exposed.

Several woods were tested which had been taken from an aeroplane that had failed. Ash gave values ranging from 355 to 432 (mean 405) kg./cm.^{2} in compression; strength in bending, 945 kg./cm.^{2}. These figures compare with 428 and 753 kg./cm.^{2} respectively found by Wiykander and with 535 and 999 kg./cm.^{2} found by Janka for American ash. Red deal (Kiefernholz) gave values ranging between 393 and 685 (mean 537) in compression, and 826 to 1016 (mean 940) kg./cm.^{2} in bending tests. Earlier tests from 310 experiments had given mean values of 498 in compression and 991 to 1265 kg./cm.^{2} in bending tests. For pitch pine the figures are : in tension 566; in compression 460 kg./cm.^{2}. An aluminium bronze cable composed of 6 wires and one core wire, for use as an electrical conductor, showed that the strength of the cable was equal to the sum of the strengths of the component wires. The wires showed $\sigma = 7630$, $\sigma_B = 10{,}080$ kg./cm.^{2}, with an elongation of 3·1 % on a length equal to 35 diams.

Tests were carried out on two steel balls placed one vertically over the other. For 2-in. balls 118,200 kg. was found; for 2½-in. balls 186,200 kg. Electrically produced steel was also investigated as regards its torsional rigidity. The proportionality limit σ_p ranged from 1720 to 2780 kg./cm.^{2}; the shearing modulus from 800,000 to 850,000 kg./cm.^{2}; elastic limit, σ_S, from 2920 to 3950 kg./cm.^{2}; the breaking strength, σ_B, from 7190 to 8470 kg./cm.^{2}. The breaking strength is of small importance, since fracture occurred only after numerous twistings. Lamp filaments (metallic) were investigated as regards the determination of flexibility after different lengths of time they had been running. The resistance to bending was found to be exhausted after about 800 to 1000 hours' running. Carbon electrodes of 40 cm. × 40 cm. cross-section, joined together by means of screw nipples, were tested in tension. The nipples broke at tensions of 20 to 25 kg./cm.^{2}. L. H. W.

808. *Mechanical Basis.* **H. M. Dadourian.** (Amer. Journ. Sci. 37. pp. 157–169, Feb., 1914.)—Both for statics and dynamics the author proposes to make the following single principle the foundation of mechanics :—The sum of all the external actions to which a body (system) or a part of a body (system) is subject at any instant vanishes. $\Sigma A = 0$. In the case of acceleration the product, Mass into reversed acceleration is reckoned as one of the actions. E. H. B.

809. *Einstein's Gravitation Theory.* **G. Mie.** (Phys. Zeitschr. 15. pp. 115–122, Feb. 1, and pp. 169–176, Feb. 15, 1914.)—A highly analytical treatment of this new theory of gravitation, which is connected with the hypothesis of a variable speed of light and a modified form of the relativity theory. *Erratum.* (Ibid. p. 263, March 15, 1914.)—[See Abstract No. 840 (1913).] **A. Einstein.** (Ibid. pp. 176–180, Feb. 15, 1914.)—A mathematical discussion in reply to Mie. E. H. B.

810. *Structure of the Atom.* **W. Peddie.** (Phil. Mag. 27. pp. 257–268, Feb., 1914.)—The paper is directed to substantiating the author's claim at the 1912 British Association discussion on spectra that, with rotating spherical distributions of electricity as constituents of the atoms, the available constants can be determined so as to account for the observed variations of spectra under different physical conditions without infraction of the hitherto accepted dynamics. J. J. Thomson's recently suggested atomic mechanism [Abstract No. 14 (1914)] accounts for many of the peculiarities in question. Structural atomic conditions can also account for the non-entrance, at ordinary temperatures, of more than five of the freedoms of a molecule of a diatomic gas in molecular interchanges of energy, showing that an exception to the equipartition law does not necessarily involve the violation of accepted dynamical laws.

A centrally symmetrical atom is posited, having regions of attractive force to meet the conditions of stable electron circulation, alternating with regions of repulsive force to meet the conditions of electron expulsion without necessary absorption of much radiation energy; and the total work done by the repulsions on an ejected electron must exceed that done by the attractions by the amount necessary to account for the speed of ejection. The law of radial force-variation must be such as to account for any observed spectrum series. Many structural arrangements can be devised to fulfil these conditions. The one here considered is the spherical counterpart of the Thomson atom referred to above. Such an atom accounting for Balmer's H series is shown to account completely for the readiness with which weak ultra-violet light or Röntgen radiation can liberate electrons possessing the energy quantum. The quantum comes, not from the radiation, but from the energy of the electron when it enters the atom, and is stored for future use. With surface distributions of electricity arranged to give thin shells in which stable circulation of an electron is possible, the resultant force upon an electron in all other regions will be ejective, so that an electron entering the atom with a moment of momentum opposed to that of the shells determining the field must be ejected. This applies also to *any* electron whose path is inclined at more than a very small angle to the equatorial plane of the atom. Such an atom provides a possible physical basis for the magneton, and, if different stable arrangements with direct or reverse alignment of the shells be possible, conditions will exist in which fundamental changes in spectra may occur. The existence of more than one stable condition requires more than three shells, and such an atom might be magnetic or non-magnetic, so that the non-magnetic condition of a substance might possibly arise, not only from counteraction of the effects of individually magnetic atoms, but also by counteraction of the effects within the atom. Radio-activity might be caused by slowing down of the angular velocities producing rearrangement of the alignment of axes. Under sufficient shock a series of shells might be ejected together, *e.g.* an α-particle or He-atom. G. W. DE T.

811. *Constitution of Atoms and Molecules.* III. **N. Bohr.** (Phil. Mag. 26. pp. 857–875, Nov., 1913.)—The first two Parts have already been dealt with [Abstracts Nos. 1930 (1913), 15 (1914)]. The present Part deals with systems containing several nuclei, on the same lines as in the earlier papers. L. H. W.

812. *Structure of the Atom and Intra-atomic Electrons.* **A. van den Broek.** (Nature, 93. pp. 7–8, March 5, 1914.)—Referring to Nicholson's

conclusion [Ibid. 92. p. 630, Feb. 5, 1914] that the atoms of Li, Ba, and B cannot consist of 3, 4, 5 electrons rotating round a nucleus of $3e$, $4e$, $5e$, respectively, with equal angular momenta in one circular orbit, the author points out that his theory [Abstracts Nos. 567 and 569 (1914)] leads to the same result, as, instead of 1, 0, 1, 2, 3 electrons of valency we should then expect a regular increase from 0 to 5, or no valency. No atomic model, as far as he knows, has accounted for this. He then enumerates a number of applications of his theory to observed phenomena, and claims that the construction of an atomic model is not essential to its validity. G. W. DE T.

813. *Kinematics of Born's Rigid Body.* **L. Föppl** and **P. Daniell.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 4. pp. 519–529, 1913.)—Four-dimensional analysis. E. H. B.

814. *Ship Resistance: the Wave-making Properties o, Certain Travelling Pressure Disturbances.* **T. H. Havelock.** (Roy. Soc. Proc. Ser. A. 89. pp. 489–499, Feb. 2, 1914.)—Mathematical; mainly with reference to G. S. Baker and Kent (Inst. Naval Architects, Trans. 1913).

815. *Deep Water Waves.* **J. R. Wilton.** (Phil. Mag. 26. pp. 1053–1058, Dec., 1913, and 27. pp. 385–394, Feb., 1914.)—Mathematical.

816. *Viscosity of Liquids under High Pressure.* **O. Faust.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 4. pp. 489–508, 1913.)—Measurements of viscosity have been made up to a pressure of 3000 kg./cm.^{2}, in a steel bomb, using electrical contacts to mark the flow of the liquid. Values were obtained for ether at 0°, 20°, 34°, for carbon disulphide at 0°, 20°, and 40°, and for ethyl alcohol at 0°, 20°, 40°, and 54°. The viscosities increase very greatly with the pressure, on the average about fourfold by increasing the pressure from 1 to 3000 atmos. In the field of small volumes, in which according to Tammann the molecular attraction is constant, the viscosity tends to become a simple linear function of the volume. T. M. L.

817. *Molecular Transformation of Thin Layers on Water.* **H. Labrouste.** Comptes Rendus, 158. pp. 627–629, March 2, 1914.)—When an attempt is made to spread a solid substance in a thin layer on water by means of a suitable volatile solvent, it is often found that the substance liberated from the solvent agglomerates into scattered visible grains. Experiments with a number of substances melting between 0° and 100° show that, with all of these excepting the highly volatile tribenzoin, temperature has a very definite and important action. The results of these experiments are expressed as curves having temperatures as abscissæ and quantities proportional to the surfaces covered as ordinates. With trimyristin spread on the surface of water by means of toluene, the curve at first runs almost parallel with the axis of abscissæ and then gradually rises, the values of the ordinate being about 18 at 20° and about 28 at 30°; subsequently the curve again becomes practically horizontal. The range of temperature over which this transformation takes place, namely about 18–31°, is far removed from the melting-point of the trimyristin, 53°, at which no particular variation of the surface covered occurs. Similar results are obtained with the other substances examined, the ratio between the surfaces covered in the hot and in the cold being in all cases about 3 : 2. The change takes place in the opposite direction on cooling, and is repeated on subsequent heating, and so on.

T. H. P.

818. *Measurement of Surface Tension of Soap Films.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 17. pp. 285–299, Sept. 8, 1913.)—An account is given of some methods employed at the Cavendish Laboratory for the measurement of the surface tension of soap solution. The methods described are: (1) The *Torsion balance method,* in which a rectangular frame of wire is dipped into a soap solution and the pull of the film is measured by aid of a simple torsion balance. The value of the surface tension was found to be 27·22 dynes/cm. by this method. (2) The *Thread method,* in which the surface tension is deduced from the curvature produced in flexible threads dipped in the solution. The surface tension by this apparatus was found to be 27·17 dynes/cm. (3) The *Viscosity Potentiometer method,* in which the pressure excess due to a spherical soap film is measured, the result found in this case being 25·19 dynes/cm. (4) The *Buoyancy method,* which was suggested by the plan adopted in the calibration of the author's new micromanometer. It depends upon the difference of density between cold and hot air at the same pressure. By this method the value of the surface tension of the solution was found to be 27·07 dynes/cm. J. J. S.

819. *Liquid Films.* **W. Miehl.** (Phys. Zeitschr. 14. pp. 1218–1222, Dec. 1, 1913.)—Some new experiments are described with soap films, hinged aluminium wires, and silk threads. A number of geometrical propositions involving minimum areas are illustrated by the shapes into which the soap films contract. E. E. F.

820. *Electrically-generated Movements of Liquid Films.* **S. Mikola.** (Phys. Zeitschr. 15. pp. 211–213, Feb. 15, 1914.)—Describes the movements of films of soap solution when a current from a high-potential battery traverses them. The films were formed on an insulating frame, and the battery terminals connected to wires projecting into the film. The motion generally consists of double eddies, the phenomena having many similarities to electric endosmose. Photographs are reproduced. A. W.

821. *Microseismic Periods.* **C. Mainka.** (Phys. Zeitschr. 14. pp. 1285–1286, Dec. 15, 1913.)—Gives a set of curves showing the distribution in time of microseismic oscillations in Irkutsk and Pultovo. All periods between 3 and 7 seconds are equally frequent about the end of March. In midsummer the short periods are most frequent, and in mid-winter the longer periods (6 or 7 secs.). E. E. F.

822. *Thunderstorms as a Cause of Seiches.* **T. Okada, S. Fujiwhara,** and **S. Maeda.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 210–221, Jan., 1914.)—The paper contains the results of an inquiry into the mechanics of the action of thunderstorms in causing seiches in Lake Biwa in Central Japan, based on records made with a limnometer of the Honda pattern. A list of the most important causes is given, viz., impacts of the falling raindrops on the surface of the lake, accumulation of rain-water on one portion of the lake, impulsive action of winds on the surface, release of electric attraction of thunder-clouds, sudden changes of the barometric pressure, and their relative importance in generating seiches is considered both statically and dynamically. For purposes of mathematical treatment the case of a rectangular lake is taken. The theoretical results compare very favourably with the data obtained during a remarkable thunderstorm which swept over the lake on April 19, 1912. H. H. Ho.

823. *A Simple Theory of Ocean and Primitive Continent Formation.* **E. Belot.** (Comptes Rendus, 158. pp. 647–649, March 2, 1914.)—The author commences by remarking that upon the earth and on Mars the ocean surface is much greater in the southern hemisphere than in the other, while upon the moon the volcanic area is much more intense in the south than north, and he opines that this latter points to a similar inequality of distribution of the water originally on the moon. This unipolar condensation of water on the earth, moon, and Mars, may be easily explained if the relative translation of these three stars in the primitive nebula be assumed, the direction being that of the north part of their axes. This south-north translation had three principal effects: (1) The plastic terrestrial projectile became flattened in front and pointed behind. (2) The rotation, more retarded at the north than at the south pole, gave a twist to every relief in the sense of an easterly rotation of their southern parts. (3) At the exterior of the primitive terrestrial atmosphere, friction upon the nebula determined a general circulation in the sense N.-S. This circulation has been demonstrated and investigated by Boussinesq in the case of a drop of water falling through a liquid. About the south pole the atmospheric circulation caused cold vertical currents to descend, and after heating at the earth's surface to ascend hot. Consequently the temperature fell below 364° (the critical temperature of water), producing an abundant condensation of water under the pressures then prevailing. The water currents then set up proceeded to weather out the configuration of the primitive continents. This theory is illustrated by numerous examples of present continental conditions, which in the opinion of the author go to confirm his views. H. H. Ho.

824. *Seismological Evidence regarding the Earth's Interior.* **B. Gutenberg.** (Phys. Zeitschr. 14. pp. 1217–1218, Dec. 1, 1913. Extract.)—A discussion of seismometer observations taken at Göttingen. Only those records are chosen in which the epicentre was more than 80° below the horizon, and certain within 3°. The velocities and intensities of the direct and reflected waves are best accounted for by assuming the existence of a marked discontinuity 2900 km. below the surface as suspected by Wiechert (1907). E. E. F.

825. *The Solar Constant of Radiation.* **C. G. Abbot.** (Washington Acad Sci., Journ. 4. pp. 89–110, March 4, 1914. Address delivered before the Phil. Soc. of Washington, Jan. 3, 1914. Science, 39. pp. 335–348, March 6, 1914.)—Summarises work done on the subject and the results already made known in various of the author's earlier papers [Abstracts Nos. 795 (1912), 1606 (1913)]. The mean value from 690 measurements of the solar constant is given as 1·933 cals. per cm.^{2} per min. Reference is made to recent experiments with sounding balloons and with which pyrheliometer measurements at altitudes as great as 40,000 m. are hoped for. L. H. W.

826. *Summary of the Free Air Data obtained at Mount Weather for the Five Years, July 1, 1907, to June 30, 1912.* **W. R. Blair.** (Mount Weather Observatory, Bull. 6. pp. 111–194, 1914.)—During the period 1682 ascents were made on 1827 days. For the first 4 years only air pressure, temperature, and wind direction aloft were recorded. During the fifth year wind velocity and relative humidity were also measured. Details are given of the instruments used and of the method of calibration adopted. A method of increasing the sensitiveness of the hygrometer was found in separating the individual hairs to allow the air free access round each. Mean temperatures for levels 250 m. apart are given for each month. The temperature maximum at the surface was found in July, but at the 4·5-km. level in Aug. The question of how far the 5 years used may be regarded as typical years is discussed, and the effect of certain small sources of error considered. The observations are grouped according as they were made (1) in a high-pressure area, (2) in a low-pressure region, or (3) in the intermediate space between high and low. Groups (1) and (2) are also separated into four quadrants chosen relative to the direction of travel of the high- or low-pressure centre. The temperature gradient between 2·5 to 4 km. above M.S.L. is less variable from season to season and from quadrant to quadrant than that at lower levels. All levels considered, summer temperature gradients are the largest and winter temperature gradients the smallest in all the groups. The differences of temperature which occur on clear, calm days between Mount Weather and three valley stations in the neighbourhood are discussed at some length. The observations on wind velocity show a fairly rapid increase up to 1 km. above the earth's surface with all wind directions. The higher the wind velocity the further up this rapid increase extends. Considering the N. and W. components of the wind, the N. component on the whole varies little with altitude, while the W. component increases slightly with height, except for the first km. above the ground with east winds. The results are presented in 27 tables and many diagrams. J. S. Di.

827. *Oxygen in the Sun.* **C. Runge** and **F. Paschen.** (Phys. Zeitschr. 14. pp. 1267–1269, Dec. 15, 1913.)—The evidence for the presence of oxygen in the sun (Runge and Paschen, 1897) rests upon the observation of three red oxygen lines. That other lines are not present is not surprising, since the heads of series have an exceptionally high absorbing power. Geiger has observed (1912) the same lines in the spectrum of the iron arc. The authors have photographed the iron arc with a Rowland concave grating of 3 m. radius, and found all the lines described by Geiger, but the three lines corresponding to oxygen were only found in the neighbourhood of the anode, where the arc played about a drop of oxide. If the arc was obtained by putting a piece of iron on a carbon anode, no "oxygen" lines were obtained. The authors conclude that the solar lines 7772·01, 7774·21, and 7775·50 Å., are really due to oxygen. E. E. F.

828. *Sun-spots and Meteor Swarms.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 74. pp. 82–109, Dec., 1913.)—In previous papers [Abstracts Nos. 39 (1914), 408 (1914)] various methods of analysis of the Wolf sun-spot numbers have been discussed, and the occurrence of *abrupt* changes in the series was suspected. The analytical method of detecting the discontinuities is described in detail. From the epochs of these disturbances a new theory is postulated involving the perturbation of the Leonid swarm of meteorites by Saturn. C. P. B.

829. *Retrograde Satellite Orbits.* **J. Jackson.** (Roy. Astronom. Soc., M.N. 74. pp. 62–82, Dec., 1913.)—With the exception of Darwin's investigation of periodic orbits, all the analytical discussions of the problem of three bodies have only dealt with *direct* motions. The discovery of Phoebe and J VIII moving in retrograde orbits at great distances from their respective primaries rendered it important that a discussion of the peculiarities of retrograde satellite motion should be undertaken, and the results are given in full in the paper. C. P. B.

830. *Astronomical Refraction.* **C. Arnaud.** (Comptes Rendus, 158. pp. 168–169, Jan. 19, 1914.)—Approximate formulæ have been given in a former note [Ibid. 156. pp. 1962–1964, June 30, 1913]. Further analysis is found to lead to a closer result, and the amended formulæ are given in form for logarithmic computation. C. P. B.

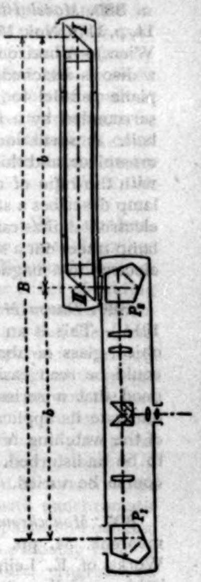
831. *Faint Companion to Capella.* **R. Furuhjelm.** (Astronom. Nachr. No. 4715. Nature, 92. p. 724, Feb. 26, 1914. Abstract.)—Evidence is given of the existence of a 10·6 magnitude star as companion to Capella, situated at a relatively great distance from the primary (12′ 3·3″). The detection was effected by comparisons of the proper motions of stars in the neighbourhood. C. P. B.

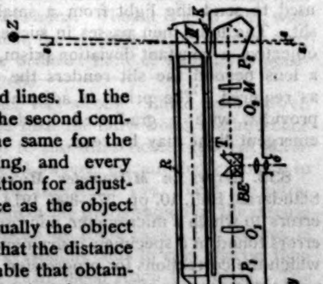
832. *Variations of Stellar Spectra and Proper Motions.* **W. S. Adams.** (Astrophys. Journ. 39. pp. 89–92, Jan., 1914. Contribution from the Mt. Wilson Solar Observatory, No. 78.)—One of the methods proposed by Kapteyn for the investigation of the question of the absorption of light in space is the comparison of the intensity at several different wave-lengths of the spectra of stars which are known to be near the earth with such as are very distant. The effect of general absorption or scattering increases towards shorter wave-lengths, and if such absorption is present in space we should expect the spectrum of the more distant star to fall off more rapidly in intensity towards the violet than would the spectrum of the nearer star. To investigate this a number of spectrograms of pairs of stars have been secured with the Cassegrain spectrograph at the Mount Wilson Observatory, care being taken to obtain approximate equality of density at the less refrangible end of the spectra. Also the spectral types of the two stars should be as similar as possible, and the photographs taken when the stars are at nearly the same zenith distance. Out of 20 pairs examined, 14 show a marked difference of intensity in the violet, and in every case the star of small proper motions is relatively faint. C. P. B.

833. *Kinetic Theory of Star-clusters.* **J. H. Jeans.** (Roy. Astronom. Soc., M.N. 74. pp. 109–112, Dec., 1913.)—An examination is made of the degree to which the results of the kinetic theory of gases may be applied to the analysis of the motions and distribution of the stars of a *star-cluster.* It is concluded that there is no possibility of a universe such as we know coming to a final steady state such as is found in the theory of gases. C. P. B.

LIGHT.

834. *New Tachymeters with Absolute Correction.* **R. Stützer.** (Zeitschr. Instrumentenk. 34. pp. 1–11, Jan., and pp. 33–42, Feb., 1914.)—The military surveying instruments described belong to the class for finding one side of a triangle from the base and two adjacent angles. The novel feature in their construction is that the system of reflecting prisms required for correcting the instrumental adjustments can be shifted into a second position to be utilised for providing a sufficiently long base-line during the process of actual measurement. An instrument of this type can be folded for transport, and when so folded is in the shape adapted for the preliminary observations for adjustment, all ready for beginning work on arrival. When the adjustments are made, the instrument can be extended by sliding the prism tube into the second position, and the measuring observations can then be undertaken. It is necessary for the prisms to have fixed deviation, either singly or in pairs, and hence only those systems are suitable which obey the ordinary laws of double or triple mirrors. In the case of the instruments dealt with in the first article, the base-line reduces to zero when the prisms are in the position for making adjustments, and the mark observed may be at any distance. Various forms of construction are described, differing in the nature of reflecting the system employed, which may be an ordinary prism with one reflecting surface, or a "rhombic" system with two nearly parallel reflecting surfaces, or there may be three reflecting surfaces. One form of construction (rhombic) is shown in the accompanying diagram. I and II are two reflecting prisms rigidly attached to the ends of the tube R, having their reflecting faces nearly parallel. The course of the rays is shown by the dotted lines. In the case of the instruments dealt with in the second communication, the length of the base is the same for the operations of adjusting and measuring, and every measure must be preceded by an operation for adjustment upon a mark at the same distance as the object whose distance is to be measured. Usually the object itself will serve as mark. It is claimed that the distance can be measured with an accuracy double that obtainable with any of the older instruments having the same base and optical power. An instrument of the new type, say, for example, 60 cm. long when folded for transport, will when extended provide a base-line 1 m. long, and attain an accuracy equal to that of an old 2 m. instrument. A table of errors for a





new instrument of the above size is given at the end of the paper. Various modes of construction are described: one form gives greater speed, another greater accuracy, yet a third form may be utilised alternatively with either view. While the instruments in the first article are more exclusively adapted to military purposes, those in the second might be applied to general purposes of topographic tachymetry. A. E.

835. *Model Illustrating the Zeeman-effect.* **P. Spies.** (Phys. Zeitschr. 14. p. 1179, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—A horizontal shaft ends in a balanced crosspiece to the end of which a disc is attached, as well as another crosspiece capable of rotation in a plane parallel to that in which the first crosspiece rotates. The shaft is surrounded by a fixed disc connected to the movable disc by means of a belt. A small incandescent lamp is attached to the end of the second crosspiece, and this lamp traces out curves varying in shape and complexity with the ratio of diameters of the two discs. When these are as 2 : 1, the lamp describes a straight line. The effect of a magnetic field on a revolving electron is illustrated by making the ratio slightly different, whereupon the lamp traces out a star-shaped figure representing the actual movement of an electron in a magnetic field. E. E. F.

836. *Davon Micro-telescope.* **C. V. Boys.** (Nature, 92. p. 595, Jan. 22, 1914.)—This is an interesting combination of microscope with a telescope object-glass of about 5¼ in. focus below the stage. Medium printed type could be read easily at a distance of 842 in., and the definition was so good that a series of artificial stars in tin-foil were without colour. To illustrate its application to natural history observation, a description is given of the watching of mice feeding 4 yards away, sufficiently distant for them to be undisturbed. The magnifying power used is about 42, but may of course be varied. C. P. B.

837. *Monochromator.* **M. Berek** and **F. Jentzsch.** (Zeitschr. Instrumentenk. 34. pp. 47–51, Feb., 1914. Communication from the Optical Works of E. Leitz.)—Describes a small monochromator giving intense light, specially suitable for microscope work. A total reflection prism is used to send the light from a small arc vertically downwards through a slit. The light then passes in succession through an achromatic collimator objective, a constant deviation prism, a second objective and a second slit; a lens beyond the slit renders the emergent light parallel or convergent as required. The prism is adjustable by means of a screw of fine pitch provided with a graduated head from which the wave-length of the emergent light may be read. A. W.

838. *Errors in Micrometer Microscopes.* **A. W. Gray.** (Bureau of Standards, Bull. 10. pp. 375–390, 1914.)—Reviews the nature of the possible errors to which a micrometer microscope is liable and gives a table of the errors found in 5 specimen instruments. The author describes a method by which the corrections for progressive and periodic errors in such instruments as the microscopes of a transverse comparator may be made very readily, the microscopes having been calibrated once for all. The results of each calibration are embodied in a table giving directly for each tenth of a turn the total correction to be added to the reading of the micrometer. The corrections for the hundredths are obtained by interpolation. All corrections are given in terms of the microscope division as unit, so that they may be applied directly

and multiplication by the reduction factor be deferred until the end. The specimen calibration described was made by removing the ocular of the microscope under examination and measuring the displacements of a spider line on its screw by means of an auxiliary micrometer microscope. Three sets of measurements were made: (i) the distance travelled by the spider lines as the screw under investigation was advanced 5 whole turns; (ii) the distance travelled during each single turn; and (iii) the distance travelled during each fifth of a turn. This was done (with some exceptions noted in the paper) for the whole length of the screw, and the results plotted for each set of observations. These three sets of curves were then made mutually consistent, and the smoothed curves thus obtained gave (after reductions (i) to the units noted above and (ii) in order to bring the points of smallest correction as near as possible to the centre of the screw) the differences to be entered in the table. This was done for each of the two microscopes composing the comparator and exceedingly consistent results were obtainable by correcting from the tables drawn up in this manner. J. W. T. W.

paper read before Roy Soc. Nov. 13. 1913

839. *Preparation of Eye-preserving Glass for Spectacles.* **W. Crookes.** ? (Roy. Soc., Phil. Trans. 213. pp. 1–25, Feb. 5, 1914.)—The paper describes experiments carried out in connection with the Glass Workers' Cataract Committee of the Royal Society, since March, 1909, on the effect of adding various metallic oxides and earths to the constituents of glass in order to cut off the invisible rays at the ends of the spectrum. The author had the assistance of H. Powell, of the Whitefriars Glass Works, who prepared several pots of coloured glass from formulæ on a larger scale than was possible in the laboratory. The main object is to prepare a spectacle glass to prevent the heat rays from highly heated molten glass from damaging the eyes of workmen, but the work also involves an investigation of the screening properties of glass plates for ultra-violet and for luminous light. By way of preliminary, a number of photographs of spectra of molten bottle-glass were taken at Messrs. Nuttall's Glass Bottle Works by means of a quartz spectrograph with panchromatic films. The bottle-glass was composed of silica, sodium sulphate, and calcium carbonate or sulphate, and the temperature in the tank was probably 1200° C. to 1500° C. The photographed spectrum is found to extend progressively into the ultra-violet as length of exposure increases, reaching to λ4520 with 20 minutes' exposure, and to λ3345 with 180 mins. Thus it is seen that, with an exposure of 3 hours to the greatest heat, the strength of impression does not extend far into the ultra-violet. The ordinary limit of visibility is generally taken to lie between λ3900 and λ7600.

The heat rays from the molten glass are very strong. Since the infra-red rays are present in far greater abundance than the ultra-violet, the inference is that it is to the heat rays rather than to the ultra-violet rays that glass-workers' cataract is to be ascribed. It is, however, certain that exposure to excess of ultra-violet light also injuriously affects the eye. That the ultra-violet rays act on the deeper-seated portion of the eye is shown by the intense fluorescence of the crystalline lens induced by these rays. The cornea is opaque to rays shorter than λ3200, the crystalline lens to rays shorter than λ3500, and rays of longer wave-length than λ3500 reach the retina. The author notes that, with a quartz spectroscope, he could formerly see the line M, λ3727, and it may be taken that the ultra-violet rays to be cut off as injurious are those of wave-length shorter than, say, λ3700. Besides the invisible rays at each end of the spectrum, the purely luminous rays if present in abnormal intensity are found to damage the eye. Tests made to see if X-rays could be detected confirm Burch's conclusion that X-rays are not emitted by the highly incandescent molten glass. To be generally useful it is desirable to obtain a glass opaque to wave-lengths longer than about λ7200 and shorter than about λ3550. To solve the problem of the best material for protective spectacles, various glasses were made in the laboratory, using as basis a clear soda flux, not containing lead (supplied from Whitefriars Glass Works in a crushed state), and adding to it quantities of pure metallic oxides and earths as colouring or absorbing media. An early paper by Faraday "On the Manufacture of Glass for Optical Purposes: Bakerian Lecture, 1829" (Roy. Soc., Phil. Trans. p. 1, 1830) was found useful. At first, single metals were tried in varying quantities. For testing purposes each specimen of glass is cut and polished into a plate 2 mm. thick. The plate so prepared is first tested in the spectrum apparatus to ascertain the upper limit of transmission of the ultra-violet rays. It is next put into a special form of radiometer balance to see the percentage of heat cut off, then tested in Chapman Jones's opacity balance (Photographic Journ. 23. p. 99) to see the percentage of luminous rays transmitted, and finally the colour is registered in a Lovibond's tintometer. In making the heat tests, Melloni's thermopile was found to respond to orange and red rays as well as infra-red, and therefore a piece of biotite or black mica was used in conjunction with it. Biotite resembles dark smoky quartz in transmitting nearly all the heat, whilst cutting off 80 or 90 per cent. of the light, and it is easier to work with. A large number of metallic elements were tested in this manner, many of which proved unsuitable. The following were selected as most promising for further experiment in combination, and details are given regarding their behaviour: Cerium, chromium, cobalt, copper, iron, lead, manganese, neodymium, nickel, praseodymium, uranium. Curiously enough, a glass in which black biotite was used as an ingredient shows the opposite effect to what might be expected, being almost opaque to the heat rays. It allows 30 per cent. of incident light to pass through, and is opaque to ultra-violet beyond λ3610.

Over 300 tinted glasses of known composition have been made and tested. The ideal glass that will fulfil the three conditions of perfect opacity to heat, perfect opacity to ultra-violet, and transparency to visible rays, has yet to be discovered, but it is now possible to choose a glass to fulfil any one of the three conditions perfectly and the other two fairly well. For the desired object, it is not an unmixed advantage for the glass to be quite clear. A tinted glass combining good obstruction to the heat radiation and ultra-violet is the best to aim for. Grey or neutral tints are the pleasantest to wear, as they do not alter the colours of objects. The outcome of the investigation is a selected list of 21 glasses possessing valuable qualities in respect of athermancy, adiactinity, and transparency. They include specimens suitable for spectacles for all requirements, and are tabulated in four classes, designed respectively for: I. Absorption of heat rays, II. Absorption of ultra-violet rays, III. Transmission of luminous rays, IV. Reduction of glare. Under the last head come 6 glasses described as best for general use in bright sunshine, on snow, etc. They cut off from 30 to 60 per cent. of the visible light, and also have the advantage of cutting off practically all the ultra-violet, and a considerable amount of the heat radiation. A. E.

840. *Selective Reflection of Infra-red Light by Solutions.* **A. K. Ångström.** (Phys. Rev. 3. Ser. 2. pp. 47–55, Jan., 1914.)—The max. selective reflection from water at wave-length 3·20 μ is shifted to longer wave-lengths by the addition of the strongly hydrated salts $CaCl_2$ and $SrCl_2$, but no appreciable shift was produced by adding NaCl, Na_2SO_4, KNO, or $CuSO_4$. [If this statement is correct it seems probable that figs. 1 and 8 have become interchanged in the printed paper.] A similar shift is produced by the addition of NaOH and KOH. Strong sulphuric acid gives a maximum of longer wave-length than water; aqueous sulphuric acid gives a maximum at intermediate wave-length, but of diminished intensity. T. M. L.

841. *Reflection of Long-waved Heat Rays by Rough Surfaces and Gratings.* **T. J. Meyer.** (Deutsch. Phys. Gesell., Verh. 16. 8. pp. 126–141, Feb. 15, 1914. Extract of Dissertation, Berlin.)—Measurements were made with plates of silver and nickel roughened with emery paper for wave-lengths varying from 0·6 µ up to about 800 µ. Other plates were roughened by means of a sand blast. The results are tabulated and graphed for various angles of incidence. In general an increased reflecting power was observed with increased wave-length. The gratings employed had rulings of depths varying from about 20 µ to 80 µ, width of rulings from 60 µ to 80 µ, and distance between rulings from 50 µ to 400 µ. Polarised light was used in the grating experiments, the wave-lengths ranging from 52 µ to 818 µ. With a given grating there is in general, as with the roughened surfaces, an increased reflecting power with increased wave-length, but in a few cases a slight diminution in reflecting power was observed when the wave-length of the incident light was altered from 52 µ to 110 µ. An explanation of this is to be found in the fact that with constant wave-length of the incident light and with constant depth of ruling the reflecting power increases with the distance between the rulings. With constant wave-length and grating distance the reflecting power is constant, or very nearly so, as the depth of the rulings is increased. Experiments were also made with metal wire gratings. [See also Abstract No. 1855 (1901).] A. W.

842. *Ultra-violet Photometry.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 15. pp. 1–8, Jan. 1, 1914.)—A lamp has been designed for obtaining special radiations desired for comparison lights in the photometry of sunlight in the ultra-violet. Sketches are given showing the arrangement of the electrodes, for which zinc and cadmium have been utilised in various forms. Comparison measurements are given showing the constancy of the illumination compared with the Heræus quartz mercury lamp. C. P. B.

843. *Quantitative Spectrophotography.* **H. Ewest.** (Photographic Journ. 54. pp. 99–107, Feb., 1914.)—Photographic photometry is based upon the quantitative comparison of the densities resulting from two exposures, and deducing therefrom the relation between the exposures themselves. The density of an exposed and developed plate depends upon a number of factors: λ the wave-length of the light acting, its intensity i, the time of the exposure t, the properties of the developer e, and the character of the plate p, hence $S = f(\lambda . i . t . e . p)$. λ can be easily kept the same by special decomposition, t can be measured very exactly, the constancy of i depends on the light source selected; e depends on the temperature, character, and composition of the developer and the length of time it is acting on the plate; p is a function of the mode of preparation of the emulsion, the age of the plate, its moisture content, and its sensitiveness. If the influence of λ, e, and p is eliminated $S = \phi(i . t)$ or $i = \psi(t . s)$ and for equal values of S, $i = \chi(t)$, so that $i_1/i_2 = \chi(t_1)/\chi(t_2)$. The various methods may be divided into two classes: firstly, those in which a definite assumption is made concerning the function

$\chi(t)$, and secondly, those in which t_1 is made equal to t_2, one of the light intensities being reduced in a measurable manner until $S_1 = S_2$, and therefore $i_1 = i_2$. By adopting the latter procedure the relation between the original light intensities can be calculated without making assumptions concerning the function ϕ. Methods of weakening a light intensity in a known manner are mentioned. Then methods with constant "t" are considered.

The author's apparatus, which is not intended for work of high accuracy, but primarily to test the method, is described in detail. An investigation of the errors inherent in the apparatus is made and the various possible sources of error in work of this kind are discussed in detail. In the original paper, of which this is an abstract, there are a number of curves showing the results given by the author's method in comparison with direct spectrophotometry of the same solutions. These are in very fair agreement. The suggestions for perfecting the method are :—The use of a constant light source; accurate construction; the use of a microphotometer for determining the positions of equal density on the spectrograms; coating the wedge on a quartz plate for work in the ultra-violet or the use of a stripped wedge. The use of a compensating filter adjusted to the plate to get smoother curves would be just as feasible as in Mees's method, but it is proposed instead to use a slot, in front of the wedge and plate, whose width is varied in accordance with the sensitiveness of the plate at different parts of the spectrum. A. E. G.

844. *Effect of Temperature on a Rowland Grating Apparatus.* **L. Grebe.** (Zeitschr. wiss. Phot. 13. pp. 264–268, Feb., 1914.)—Discusses the effect of variations of temperature of the room containing a concave-grating apparatus. The relative expansion and the massiveness of the grating and the rest of the apparatus are considered. The conclusion is reached that only if the temperature variations do not exceed 1 deg. C. are they without prejudicial effect on very accurate wave-length measurements. A. W.

845. *Optical Anisotropy of Liquid Crystals.* **D. Vorländer.** (Phys. Zeitschr. 15. pp. 141–145, Feb. 1, 1914.)—So far as the investigation has gone (the author has examined liquid-crystals of 900 substances, including 400 new cases) the liquid crystals of all organic compounds are optically uniaxial in their primary forms; this is associated with the "linear" form of a long chain-like molecule. The biaxial character recognised by Lehmann in *p*-azoxyphenetol is attributed to pleochroism and circular polarisation, consequent upon the addition of colophony or sugar, in liquid crystals which are still uniaxial. Again, in opposition to Wallerant, who has described biaxial plates of *p*-azoxyanisol, the author states that on cooling either thick or thin layers of the amorphous melt between a microscope slide and coverglass the pure compound gives no optic axial figures, nor can these be developed by the usual methods of mechanical disturbance; interference figures can be developed in presence of impurities, but these are always uniaxial.

The author states that optically-active liquid crystals are invariably negative in their double refraction, and that all other liquid crystals are positive. Some substances can, however, exist in both forms, *i.e.* as inactive, positive, uniaxial, liquid-crystals, or as optically active, negative, uniaxial, liquid-crystals. The optical activity of liquid-crystals is always a consequence of molecular asymmetry. T. M. L.

846. *Constancy of the Velocity of Light.* **W. de Sitter.** (Phys. Zeitschr. 14. p. 1267, Dec. 15, 1913.)—A reply to Freundlich [Abstract No. 66 (1914)]

The velocity of light may be put $=c+\mathrm{K}u$, where u is the velocity of the source. Between $\mathrm{K}=0$ (Lorentz) and $\mathrm{K}=1$ (Ritz) the choice is easy, and even Freundlich admits that the latter value is inconsistent with observations. Whether K is a measurable fraction remains to be decided. From observations on β Aurigæ the value for K is about 0·002. Against Freundlich's plea of a preference of the line of apsides for the direction of the line of sight the author brings to bear another statistical fact which is better established, viz. that spectroscopic binaries of short period, and hence large u, have smaller eccentricities than those of long period. If the velocity of light depended upon that of the source, the contrary would have to be expected. E. E. F.

847. *The Sagnac-effect. Existence of the Ether.* **H. Witte.** (Deutsch. Phys. Gesell., Verh. 16. 3. pp. 142–150, Feb. 15, 1914.)—A criticism of the conclusions deduced by Sagnac from his experiments with a rotating interferometer [see Abstracts Nos. 65 and 216 (1914)]. Witte concludes that the effect observed by Sagnac does not prove the existence of the ether. A. W.

848. *Optical Constants of Potassium and Sodium.* **B. Meese.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 580–588, 1913.)—Describes experiments with mirrors of potassium and sodium and gives the values obtained for their optical constants. These are in good agreement with those of R. W. and R. C. Duncan [Abstract No. 1269 (1913)]. E. H. B.

849. *Ponderomotive Couples of a Light Source and the Principle of Action and Reaction.* **K. Schaposchnikov.** (Ann. d. Physik, 43. 3. pp. 473–480, Feb. 10, 1914.)—Points out that Abraham's theory of ponderomotive actions in electromagnetic fields is unable to explain the above twisting phenomena. E. H. B.

850. *Theory of Light Absorption in the Atmosphere.* **M. Milankovitch.** (Ann. d. Physik, 43. 4. pp. 623–638, Feb. 27, 1914.)—A mathematical treatment on somewhat similar lines to Poynting's work on the "Surface Temperatures of Planets" [Abstract No. 898 (1908)], but conforming more closely, in the the author's opinion, to actual conditions. L. H. W.

851. *The Extraordinary Ray Resulting from the Internal Reflection of an Extraordinary Ray at the Surface of an Uniaxial Crystal.* **J. Walker.** (Phys. Soc., Proc. 25. pp. 293–299, June, 1913.)

852. *Rotatory Polarisation in Liquids.* **E. T. Paris** and **A. W. Porter.** (Phil. Mag. 27. pp. 91–95, Jan., 1914.)—In order to determine whether polarised light has a directive influence on the molecules of a sugar solution, measurements of rotatory power for the green mercury line Hg 5461 were made with sparks lasting not more than 3×10^{-6} sec. and a steady arc. The values for the spark were less by about 1 part in 13,000 on readings of about 500°, but this was regarded as within the limits of experimental error. T. M. L.

853. *Rotatory Power in Biaxial Crystals.* **F. Wallerant.** (Comptes Rendus, 158. pp. 91–93, Jan. 12, 1914.)—Measurements have been made of the rotation produced in light of different colours travelling along one optic axis of a biaxial crystal of antimony ammonium tartrate. The values obtained were :—

$\lambda=$	620	570	536	491
$\alpha=$	+139°	+168°	+185°	+249°

T. M. L.

854. *Measurement of Small Displacements of Spectrum Lines.* **J. Evershed.** (Kodaikanal Observatory, Bull. 32. Nature, 92. p. 540, Jan. 8, 1914. Abstract.)—A positive copy of the plate to be measured is made, and then placed in reverse position in contact with the original, film to film. Provision is made for moving one plate relatively to the other by any required amount controlled by a micrometer screw. The measurements are made by estimating when the positive image of a given line exactly overlaps its negative counterpart, the sensitiveness depending on the ability of the eye to recognise very slight differences of density. The method is illustrated by actual results obtained in the measurement of plates showing the solar rotation. C. P. B.

855. *Wave-length Standards.* **H. Viefhaus.** (Zeitschr. wiss. Phot. 13. pp. 209–234, and pp. 245–264, Feb., 1914.)—Describes and gives results of the measurement of a large number of tertiary wave-length standards in the arc spectrum of iron, ranging from λ2987 to λ4118. Six tables of lines are given, the mean errors of measurement of the wave-lengths varying progressively from the first, which contains lines for which the mean error does not exceed 0·001 I.Å. unit, to the last, which gives wave-lengths of lines for which the mean error is greater than 0·003 I.Å. unit. An additional table gives all the lines measured and compares the results with those of Burns [Abstract No. 1436 (1913)]. A. W.

856. *Secondary Wave-length Standards in Iron Arc Spectrum.* **H. Kayser, J. S. Ames, H. Buisson, and F. Paschen.** (Astrophys. Journ. 39. pp. 93–94, Jan., 1914.)—Experience having shown that many of the arc lines of iron are not suited for fundamental measurements of wave-length, the method of selection and conditions for producing the arc were agreed to by an international committee during the Solar Union meeting at Bonn in Aug., 1913. It was resolved: (1) That the length of the arc should be 6 mm. (2) For wave-lengths greater than λ4000 the current should be 6 amps., and 4 amps. or less for shorter wave-lengths. (3) Continuous current should be used, at 220 volts, with 7-mm. diam. as electrodes. The arc should be vertical, the positive electrode being the upper one. (4) The middle part of the arc, in its axis, for a length of 2 mm., should be used. (5) Only the lines belonging to the groups *a*, *b*, *c*, *d* of the Mount Wilson classification should be used. The committee recommends that many more secondary standards be determined, to allow of more convenient interpolation. A list of the adopted secondary standards of iron and nickel is included in the paper. C. P. B.

857. *Arc Spectrum of Iron.* **K. Burns.** (Lick Observatory, Bull. No. 247. Zeitschr. wiss. Phot. 13. pp. 235–244, Feb., 1914.)—Using a 21·5-ft. Rowland concave grating mounted in the Abney style, with grating and camera fixed, slit moving round a circular arc having a radius equal to half the radius of curvature of the grating, the arc spectrum of iron has been photographed from λ3206 to λ7800. The results are presented as a contribution to the International Standards of Wave-lengths, and comparisons are given with the results of other workers on the same spectrum. C. P. B.

858. *Spectrum of Calcium Arc in Vacuo.* **H. Crew and G. V. McCauley.** (Astrophys. Journ. 39. pp. 29–33, Jan., 1914.)—A new series of spectra of the calcium arc *in vacuo* have been investigated for the determination of the wave-lengths on the international system, it being found that the lines obtained at low pressure (about 1 cm.) were much better defined than at

ordinary atmospheric pressure. The wave-lengths tabulated extend from λ2103·289 to λ7826·099. Eleven new lines were found, eight of these belonging to the first subordinate series of main triplets. C. P. B.

859. *Resonance and Selective Superficial Diffusion of Sodium Vapour for D-light.* **L. Dunoyer.** (Journ de Physique, 4. Ser. 5. pp. 17–34, Jan., 1914.)—The light from a carbon arc gives rise in sufficiently pure Na-vapour to an orange fluorescence [Abstract No. 1340 (1912)]. The light from that part of the arc near the negative carbon excites this fluorescence much more strongly than that from the positive crater. A bright surface glow may be obtained where the exciting light enters the vapour. This surface effect was studied in detail. Different parts of the arc flame differ much in their power to produce this superficial resonance. The edge of the flame is particularly rich in exciting rays. Putting salt into the positive crater increased the yellow colour of the arc flame, but the surface resonance was less intense than without it. The effect is exhibited best when the temperature of the bulb containing the Na-vapour is raised to about 250° or 300°. Certain experiments tend to show that the light which is effective in producing the surface resonance is confined to the central parts of the sodium D_1 and D_2 lines. A Savart polariscope was used to investigate the light emitted by the surface resonance, but no trace of polarisation could be observed whether the incident light was polarised or not. The addition of hydrogen to the Na-vapour diminishes the intensity of the surface resonance without altering its character, though at first it appears to have the effect of increasing the intensity of the volume resonance. In the latter part of the paper the resonance phenomena of the vapours of Na and Hg are compared [see Abstract No. 1182 (1912)]. A. W.

860. *Variability of Absorption Spectra.* **G. H. Livens.** (Phys. Zeitschr. 14. pp. 1271–1273, Dec. 15, 1913.)—It appears almost certain that only a small proportion of the atoms, say, of Na-vapour, are at any given instant effective in producing an absorption line, perhaps one in a thousand. The absorbing action only takes place during ionisation or recombination. That being so, it is clear why heat increases the absorbing power of a given amount of vapour, the ionic processes being livelier. The observation that heat has the same effect as an increase of density is thus qualitatively explained. [See also Abstract No. 227 (1914).] E. E. F.

861. *New Type of Absorption Spectra.* **J. Koenigsberger** and **K. Vogt.** (Phys. Zeitschr. 14. pp. 1269–1271, Dec. 15, 1913.)—The vapour of "tetrazine" $C_2N_4H_4$, discovered by Curtius, shows very peculiar absorption lines. The spectrum resembles the absorption line spectrum of metallic series, such as has not hitherto been found in compounds. The lines show no discoverable Zeeman-effect; nor do they show the magnetic double refraction characteristic of band spectra. They do not form a spectrum series. Certain lines, though sharp, show a continuous background (also found in some metallic lines). On heating the vapour to 35° a bright line appears just beside each of the absorption lines, even when the pressure is as low as 17 mm. Hg. These bright lines are not true emission lines, but probably due to some kind of "directed resonance" such as is assumed according to Huyghens' explanation of the rectilinear propagation of light. E. E. F.

862. *Quantitative Investigation of the Absorption Spectra of Solutions by Means of the Radiomicrometer.* **H. C. Jones** and **J. S. Guy.** (Ann. d.

Physik, 43. 4. pp. 555–604, Feb. 27, 1914.)—An account of investigations, the results of which have been published previously [see Abstracts Nos. 880 (1907), 68, 1276 (1913)], and dealing especially with the absorption spectra of solutions of salts of neodymium, praseodymium, nickel, and cobalt. T. S. P.

863. *Line Spectrum of Nitrogen in a Geissler Tube.* **C. Porlezza.** (Gazzetta Soc. Chim. Ital. 43. ii. pp. 699–708, 1913.)—Gives the results of measurements of the wave-lengths of the lines of this spectrum, many of which have hitherto been ascertained only approximately. L. H. W.

864. *Spectrum of Nitrogen in Magnetic Field.* **H. Deslandres** and **L. d'Azambuja.** (Comptes Rendus, 158. pp. 153–159, Jan. 19, 1914.)—Following on the recognition that when a light source giving band spectra is placed in a magnetic field the rays of the same arithmetic series are all displaced in the same sense or are divided in the same manner, with any dissymmetry in the same sense, the authors proceed to examine in detail the influence of the magnetic field on the second group of nitrogen bands. For some time after the discovery of the Zeeman-effect it was thought that *band* spectra were exempt from the division shown by *line* spectra, but this was apparently due to insufficient magnetic power, as it has recently been shown by Fortrat [Abstract No. 668 (1914)] that when a field of 40,000 to 50,000 gauss is employed certain displacements are detected, but there is no division and no polarisation. In the present author's experiments a field of 85,000 gauss has been used, in conjunction with a very powerful spectrograph giving a dispersion of 1·40 mm. to 1 Å. at λ400, and the observations have been made both parallel and perpendicular to the field. Sketches are given showing the displacements found on the photographs. C. P. B.

865. *Band Spectra in Magnetic Field.* **R. Fortrat.** (Comptes Rendus, 158. pp. 334–335, Feb. 2, 1914.)—Referring to the paper by Deslandres and d'Azambuja [see preceding Abstract], it is pointed out that they do not appear to have followed out the effects produced by variations of field strength. By doing this a measure of the *sensibility* of the different rays can be obtained. If n is the natural separation of a group of rays of a doublet or triplet, δn its diminution by field H, the value $n \, . \, \delta n/H^2$ is constant for the same grouping, and may be taken as a measure of the sensibility to the effect of the field. C. P. B.

866. *Zeeman-effect and Quantum Theory of Spectral Series.* **K. F. Herzfeld.** (Phys. Zeitschr. 15. pp. 193–198, Feb. 15, 1914.)—The magnitude of the Zeeman-effect is calculated in accordance with the quantum theories of spectral series of Hasenöhrl and Bohr [Abstracts Nos. 205, 1930 (1913)]. On both theories the electron acquires in the presence of a magnetic field a precession motion. Many suppositions are possible in both theories. The simplest and most plausible is that the quantum laws hold good with regard to a plane which takes part in the precession motion. Both theories then give normal triplets. Further, Bohr's theory gives a separation and broadening proportional to the square of the field strength, and it follows also that the radius of the orbit of an electron is large with respect to that of the atom. A. W.

867. *Zeeman-effect in Satellites of Mercury Lines.* **H. Nagaoka** and **T. Takamine.** (Phil. Mag. 27. pp. 333–343, Feb., 1914.)—A brief review is first given of earlier work on this subject. The object of the research dealt

with in the latter part of the paper was to follow the whole course of the change in the lines from weak to strong fields, and to show that the separation of the lines is not generally subject to the law of linear proportionality to the magnetic force, including the singular case, in which change of wave-length is proportional to the square of the magnetic field, as one type of separation. It is further shown how the satellites gradually tend to approach asymptotically the branches of the principal line when the field is sufficiently increased. An échelon spectroscope was used, combined with either a Lummer-Gehrcke plate or, preferably, a sliding Fabry-Perot interferometer for eliminating false lines. A brief account of the research has previously been given [Abstract No. 1958 (1913)]. More detail is now given and typical photographs are reproduced. A. W.

868. *Secondary Rays due to Hard X-rays.* **J. Laub.** (Phys. Zeitschr. 14. pp. 1209–1210, Dec. 1, 1913.)—Announces the discovery of a harder homogeneous fluorescent X-radiation in Pt and Zn, with absorption coefficients 7·2 and 5·4 $cm.^2 \ gm.^{-1}$ respectively. Sulphur and carbon emit a very hard homogeneous radiation with absorption coefficients 0·21 and 0·37. The author holds that Pt and Zn emit a series of fluorescent "Röntgen lines," whereas carbon and sulphur emit only one sharp line each. This sharp and hard radiation belongs to a new class of secondary rays. It has not been observed in the case of bodies of higher atomic weight, probably because it is then too penetrating. E. E. F.

869. *New Verification of the Laws of Transparence of Matter to Röntgen Rays in the Special Case of Complex Minerals.* **L. Benoist** and **H. Copaux.** (Comptes Rendus, 158. pp. 559–561, Feb. 23, 1914.)—In order to verify the laws of transparence of matter to complex minerals the following three mineral salts are used: ferrocyanide of potassium $[Fe(CN)_6]K_4$, cobaltic chloropentamine $[Co(NH_3)_5Cl]Cl_2$, and silico-molybdate of potassium $[Si(Mo_2O_7)_6]K_4H_4 + 16H_2O$. The equivalents of transparence are calculated according to the formula $M/E = \Sigma m/e$ in which M, m, etc., represent the masses of the component elements and E, e, etc., the corresponding equivalents of transparency for the quality of Röntgen rays employed. The equivalents determined experimentally, *i.e.* fluoroscopically or radiographically, are compared with these theoretical results. It is found that the numbers obtained are in good agreement, so that it can be safely asserted that the laws of transparence, in particular the additive law, hold true for complex mineral as for other substances to the degree of approximation of the photometric measurements—that is, to 5% or less. A. E. G.

870. *Debye-effect.* **M. v. Laue** and **J. S. van der Lingen.** (Phys. Zeitschr. 15. pp. 75–77, Jan. 15, 1914.)—According to the theory of P. Debye the temperature influence on the interference phenomena with Röntgen rays decreases the brightness of the interference spots with higher temperatures, those spots nearest the incident one being, however, in general less affected than the more distant ones. The present work aims at a qualitative proof of this theoretical deduction. The experimental arrangements are shown generally and in detail by diagrams. The result of the investigation is that, at any rate qualitatively, the theory of Debye rightly expresses the influence of temperature. [See Abstract No. 1668 (1913).] E. H. B.

871. *Optics of Space Lattices.* **M. v. Laue.** (Phys. Zeitschr. 14. pp. 1040–1041, Nov. 1, 1913.)—Shows that the maxima calculated by

Ornstein's theory [Abstract No. 1666 (1913)] agree in every respect with those calculated from his own theory. Maintains that Ornstein does not clearly distinguish between "coherence" and "interference with difference of path of whole wave-lengths." E. E. F.

872. *Interference of X-rays.* **W. Friedrich.** (Phys. Zeitschr. 14. pp. 1079–1084; Discussion, pp. 1084–1087, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—An account of the discovery of X-ray interference, together with subsequent results obtained by Bragg, Moseley and Darwin, Herweg, and others. Points out the importance of determining independently the wave-length of X-rays and the grating constant. This is easier since it is possible to obtain homogeneous X-rays. In the *discussion*, **v. Kowalski** raised the question as to whether the spiral structure of quartz could be imitated by building up plates of mica. **Laue** replied that it would not be possible to space the mica plates sufficiently evenly. **Lehmann** mentioned that the failure to obtain these interference patterns in liquid crystals was due to the fact that the molecules of such crystals are not arranged in space lattices, but in rings round certain axes. E. E. F.

873. *Interference of X-rays.* **E. Wagner** and **R. Glocker.** (Phys. Zeitschr. 14. pp. 1232–1237, Dec. 1, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—A beam of X-rays is reflected at an angle of about 9° from one of the lattice surfaces of a crystal of rock-salt. A monochromatic beam corresponding to one of the interference patches is reflected similarly by a second crystal. The interference pattern thus obtained is a very simple one, due to a single wave-length or low multiples of it.

E. E. F.

874. *Optics of Space Lattices.* **L. S. Ornstein.** (Phys. Zeitschr. 14. pp. 1229–1231, Dec. 1, 1913.)—Shows that if X-rays consist of a continuous spectrum, a crystal acts as an harmonic analyser, isolating a definite wave-length. Maintains that Laue's mode of calculation leads us to regard the X-ray beam as having such a continuous spectrum. **M. v. Laue.** (Ibid. pp. 1286–1287, Dec. 15, 1913.)—Laue disagrees with Ornstein's contention that if a plane sine wave is reflected by a surface net containing N illuminated particles, the intensity of the reflected ray is proportional to N^2. It is proportional to N. That the intensity of any interference patch is proportional to N*n* (where *n* is the number of plane layers) can be derived from Laue's original equations. E. E. F

875. *Influence of Temperature in X-ray Interference.* **M. v. Laue.** (Ann. d. Physik, 42. 6. pp. 1561–1571, Dec. 23, 1913.)—From Debye's investigation of heat motion in solids, the author derives the conclusion that temperature has no appreciable effect on X-ray interference patterns, and that the peculiarities of the patterns previously attributed to heat motion are due to irregularities of structure. E. E. F.

876. *Analysis of Crystals by the X-ray Spectrometer.* **W. L. Bragg.** (Roy. Soc., Proc. Ser. A. 89. pp. 468–489, Feb. 2, 1914.)—In a former paper [Abstract No. 87 (1914)] the structures of NaCl, KCl, KBr, and KI were studied from evidence based on the Laue photographs obtained when X-rays are transmitted through the various crystals. The X-ray spectrometer, which was devised by W. H. Bragg for the purpose of studying the reflection of X-rays by crystals, affords a much more powerful method of research into the structure of the crystal [see Abstract No. 86 (1914)]. The X-ray spectro-

meter employs a monochromatic radiation and the faces of the crystal are examined in detail, one by one, by observing the angle (θ) at which the particular radiation is reflected. This gives the distance d from plane to plane parallel to the faces [$n\lambda = 2d \sin \theta$]. Moreover, if the successive planes of atoms are of identical composition, the results of the examination show this by the gradual decrease in the intensity of reflection corresponding to the various orders. On the other hand, if successive planes differ in composition the nature of the variation can be deduced from the relative intensities of the reflection in the different orders. Thus in the case of reflection from the 1.1.1. planes of NaCl the second order spectrum is about five times as strong as the first, while the third order spectrum is missing and the fourth order moderately strong. This is simply explained by assuming that the planes contain alternately either all Cl-atoms or all light Na-atoms. The first order spectrum corresponds to the spacing $d_{(111)}$ of Cl to Cl planes. The reflection corresponding to this spacing is spoilt, however, by the interposition of the lighter Na-atoms, exactly intermediate with the Cl ones. The effect of this is to weaken all the odd spectra in comparison with the even. If the Na planes were so weak as to be non-effective, the odd spectra would be of normal strength. If they become as effective reflecting planes as the Cl planes, the odd spectra would disappear entirely. What is actually the case represents an intermediate state of affairs. This justifies the structure given in the author's former paper.

More complicated crystals are next examined, proceeding on the above general lines. The angles of reflection and the intensities of the various orders are measured with Pd X-rays falling on the various faces of the crystals. The angles of reflection give the positions of the heavier atoms in the crystal. Further, on the assumption that an atom diffracts the rays to an extent proportional to its atomic weight, the positions of the other atoms are deduced from the observed relative intensities of the various orders. This assumption is verified by an interesting series of measurements with $NaNO_3$, $CaMg(CO_3)_2$, $CaCO_3$, $MnCO_3$, and $FeCO_3$, in which series the weight of the metal gradually increases towards that of the group (CO_3).

The results show that in zinc blende the Zn atoms lie on a face-centred lattice as do the Cl-atoms in NaCl. The S-atoms occupy positions at the centres of four of the eight elementary cubes inside this lattice. In fluorspar, CaS_2, the arrangement is the same as for S zinc blende except that the S-atoms are at the centres of all the elementary cubes of the space lattice. In iron pyrites, FeS_2, the Fe-atoms are again arranged as in a face-centred lattice, but the S-atoms are no longer at the centres of the figure of the structure, but on the diagonals of the elementary cubes of the lattice at a distance from the Fe-atoms 4/5 of the length of the diagonal. The structure of calcite and a few other crystals are also investigated in the paper. E. M.

877. *X-ray Spectra.* **J. Herweg.** (Deutsch. Phys. Gesell., Verh. 16. 1. pp. 73–78, Jan. 15, 1914.)—The author has investigated antikathodes of platinum and tungsten, the pencil of X-rays used emerging at a glancing angle so as to give the effect of a line source [Abstract No. 1831 (1913)]. Selenite was used as crystal, and the reflected rays were registered on a photographic plate. Five lines were found for Pt at relative angles very nearly the same as those found by Moseley [Abstract No. 467 (1914)]. The spectrum of tungsten was found to contain two lines with almost the same wave-lengths as two of the lines of Pt but with a different relative intensity.

E. M.

878. *X-ray Spectra.* **M. de Broglie.** (Comptes Rendus, 158. pp. 333-334, Feb. 2, 1914. Journ. de Physique, 4. Ser. 5. pp. 101-116, Feb., 1914.)—When X-rays are passed through a thin Pt-foil the impression on a photographic plate consists of a patch surrounded by radial stripes [Hupka, Abstract No. 1329 (1913)]. The author finds that each radial stripe shows the spectrum of the particular antikathode used.

In the course of some experiments on absorption of X-rays an interesting phenomenon was noticed. Three photographs of the spectrum of Pt were obtained simultaneously: the first without absorbing screen, the second with a thin sheet of gold as absorber, and the third with a thin sheet of Pt. The photograph with gold as absorber, showed nothing remarkable, but in the photograph with Pt absorber the lines showed an effect similar to a reversal, in that their centres showed the most absorption. This may be explained by assuming that in the production of the rays at the antikathode a phenomenon arises analogous to the Doppler-effect and that the sheet of Pt absorbs selectively by resonance. E. M.

879. *Crystalline Structures revealed by Diffraction of Röntgen Rays.* **G. Friedel.** (Comptes Rendus, 158. pp. 130-131, Jan. 12, 1914.)—The author emphasises the necessity of distinguishing in the structure of a crystal between the *space lattice* and the *assemblage;* he considers that the lattice is revealed best by cleavage and the assemblage by diffraction. T. M. L.

880. *Röntgen-ray Absorption Band.* **W. H. Bragg.** (Nature, 93. pp. 31-32, March 12, 1914.)—The author has been testing experimentally the theoretical discussions by Debye and Sommerfeld in relation to the influence of molecular motions upon reflecting power. Confirmation has been obtained of some of their predictions which is at least roughly quantitative. For instance, the intensities of the higher order spectra are much more affected by rise of temperature than the lower, and the amount of the change is of the right order of magnitude; also rock-salt and sylvine show greater changes than fluorspar. The results for the diamond have, however, been puzzling. The diamond used was a thin flake which only intercepts a fraction of the incident primary ray, a fraction which diminishes as the diamond is set at a greater angle to the primary beam. Apparently, then, allowance must be made for this waste of reflection opportunities. But the intensity ratios are, to all appearances, nearly correct before the allowance is made, and become quite wrong afterwards. The diamond behaves as if, like the other crystals, it were quite thick. Hence a search was instituted for a special absorption of rays which are undergoing reflection.

A pencil of Röntgen-rays from a rhodium bulb passes through a slit 0·1 mm. wide and falls upon the diamond, which is mounted on the revolving table of a spectrometer. The rays that pass through the diamond fall afterwards upon a crystal of rock-salt so placed as to reflect a pencil into the ionisation chamber. When the diamond is turned, a minute of arc at a time, through the angle (about 9°) at which the diamond itself reflects the principal Rh ray, the intensity of the ray reflected by the rock-salt drops in the ratio 100 to 70. Possibly this ratio could be increased by more accurate arrangement. The principal Rh ray is really a doublet, the two constituents of which are separated by an angle of 4′ under these arrangements. The doublet is resolved not only in the pencil reflected by the diamond, but also in the absorption band occurring in the reflection from the rock-salt. The effect is no doubt analogous to the selective absorption shown by crystals of potassium chlorate [see Abstract No. 1559 (1906)]. A. W.

881. *Counting of α-Particles.* **L. Myssowsky and K. Nestourkh.** (Russian Physico-Chemical Soc., Journ. 45. pp. 149–178, 1918. Le Radium, 2. p. 28, Jan., 1914. Ann. d. Physik, 48. 8. pp. 461–472, Feb. 10, 1914.)—The authors have made experiments with the apparatus originally designed by Rutherford and Geiger for the counting of α-particles [Abstract No. 1627 (1908)]. An insulated wire is fixed along the axis of a cylindrical tube containing air at reduced pressure. α-Particles enter through a mica window and the ionisation due to each is multiplied by collision so as to produce an appreciable effect on an electrometer. The natural disturbances produced in the absence of α-particles were specially investigated. The number and nature of these disturbances depends on the value of the applied potential, the dimensions of the ionisation chamber, and the state of its internal surface. If the surface is well polished and the axial wire well centred they can be made almost insensible. In these conditions, on gradually increasing the potential, a feeble, steady ionisation current is produced in the ionisation chamber, and in this state the apparatus is most favourable for observations [see also Abstract No. 246 (1918)]. E. M.

882. *Some Experiments to Detect β-Rays from Radium A.* **W. Makower and S. Russ.** (Phys. Soc., Proc. 25. pp. 258–255; Discussion, p. 255, June, 1918.)—When an atom of radium A disintegrates, an α-particle is expelled which carries with it two positive atomic charges. At the same time the radium B atom formed, recoils with a single positive charge. To account for these facts it is necessary to suppose that three negative electrons are expelled during the process. If these are emitted with a high velocity they should appear as β-rays capable of detection by the ionisation they produce or by their photographic action. On the other hand, they might consist of a slowly-moving ε radiation which would escape detection by either of the above methods. The experiments, which were made by both methods in the hope of detecting β-rays from radium A, failed to reveal any such radiation. AUTHORS.

883. *Number of Ions produced by the γ-Radiation from Radium.* **A. S. Eve.** (Phil. Mag. 27. pp. 894–896, Feb., 1914.)—If q ions are produced, directly or indirectly, in 1 cm.^{3} of air at standard temperature and pressure at a distance of r cm. from a source of 2 gm. of radium, then $q = KQ/r^2e^{-\mu r}$, where K is a constant and μ is the coefficient of absorption of γ-rays in air. Also the total number of ions produced in air by the γ-rays is $N = 4\pi KQ/\mu$. In making measurements of K an electroscope is used with thin walls of low atomic weight, *e.g.* cardboard. The author has made a redetermination of K and N, and finds $K = 4{\cdot}0 \times 10^9$ and $N = 8{\cdot}4 \times 10^{14}$ on the international standard. This latter number excludes the ions produced by easily absorbed radiations, including which Moseley and Robinson found $N = 18 \times 10^{14}$. ["Radioactive Substances," p. 295 (1918).] E. M.

884. *Secondary γ-Radiation.* **D. C. H. Florance.** (Phil. Mag. 27. pp. 225–244, Feb., 1914.)—The author has made a detailed investigation of the emergent and returned secondary γ-radiations from a radiator, using RaEm as a source of primary γ-rays. The experiments confirm the earlier results [Abstract No. 851 (1911)], that the secondary γ-radiation becomes gradually less penetrating the greater the angle it makes with the original direction of the primary beam, and, further, that the secondary γ-radiation is completely heterogeneous. As the primary γ-rays used (RaC) are initially homogeneous, this shows that a continuous transformation takes place in absorption throughout the whole range of absorbing screens, so that the primary rays cannot remain strictly homogeneous, although an equilibrium of primary and transformed radiation may be set up so as to give an exponential absorption curve. The secondary γ-radiation for all radiators is found to be different in type from the primary radiation, and it appears that in the process of scattering some modification has taken place. In the case of elements such as Pt, Hg, and Pb there is a small amount of an "extra radiation" with an absorption coefficient of about 40 cm.$^{-1}$ in lead. This "extra radiation" is probably characteristic of the radiator. The experiments show, further, that Pb produces more secondary γ-rays than does an equal mass of Al, Zn, or Sn. **E. M.**

885. *Tables of Radio-active Constants.* **L. Kolowrat.** (Le Radium, 2. pp. 1–6, Jan., 1914.)—A collection of radio-active information and constants. The following is part of one of the tables. The coefficients of absorption of the various γ-rays are given in Abstracts Nos. 478, 489, and 886 (1914).

Substance.	Valency.	Half-value Period.	Radiation.	Range (α) at 15° C.	Absorption Coefficient μ_β in cm.$^{-1}$ Al.
Uranium I	6	5·0 × 10⁹ years	α	2·5	—
† Uranium Y	—	1·5 days	β	—	about 300
Uranium X_1	4	24·6 days	β	—	510
Uranium X_2	—	1·15 mins.	β	—	14·4
Uranium II	6	2 × 10⁶ years (?)	α	2·9	—
Ionium	4	2 × 10⁵ years (?)	α	3·0	—
Radium	2	1730 years	αβ	3·30	about 200
Radium Emanation	0	3·85 days	α	4·16	—
Radium A	2	3·0 mins.	α	4·75	—
Radium B	2	26·7 mins.	β	—	75
Radium C_1 } RaC	3	19·5 mins.	α (?) β	—	13·5
† Radium C_2 } RaC	—	1·4 mins.	β	—	—
Radium C′ } RaC	—	10⁻⁶ sec. (?)	α	6·94	—
Radium D	2	16·5 years	β	—	130
Radium E	3	5·0 days	β	—	43·3
Radium F (Polonium)	2	136 days	α	3·77	—
Radioactinium	4	19·5 days	αβ	4·6	170
Actinium X	2	11·4 days	α	4·4	—
Actinium Emanation	0	3·9 sec.	α	5·7	—
Actinium A	2	0·002 sec.	α	6·5	—
„ B	2	36·1 mins.	β	—	very soft
„ C	3	2·15 mins.	α	—	—
„ D	—	4·71 mins.	β	—	28·5
Thorium	4	1·8 × 10¹⁰ years	α	2·72	—
Mesothorium I	2	5·5 years	—	—	—
„ II	3	6·2 hours	β	—	about 30
Radiothorium	4	2·02 years	α	3·87	—
Thorium X	2	3·64 days	α	4·30	—
Thorium Emanation	0	54 sec.	α	5·00	—
Thorium A	2	0·14 sec.	α	5·70	—
Thorium B	2	10·6 hours	β	—	110
Thorium C_1	3	60 mins.	αβ (?)	4·80	16·3
† Thorium D	—	3·1 mins.	β	—	
Thorium C_2	—	10⁻¹¹ sec. (?)	α	8·60	—
Potassium	1	—	β	—	about 30
Rubidium	1	—	β	—	about 300

E. M.

886. *γ-Rays from Uranium Products.* **H. Richardson.** (Phil. Mag. 27. pp. 252–256, Feb., 1914.)—The experiments show that UrX ($= X_1 + X_2$) emits three types of γ-rays having absorption coefficients in Al $\mu = 24$, $\mu = 0·70$, and $\mu = 0{\cdot}140$ (cm.)$^{-1}$. The first two types probably belong to UrX_1; the third, penetrating type, to UrX_2. The results support the view that the atomic weight of actinium is about 230, and that Ac is probably a branch product from UrX_1. [See Abstract No. 487 (1914).] E. M.

887. *Decay Constant of Actinium X.* **H. N. McCoy** and **E. D. Leman.** (Phys. Zeitschr. 14. pp. 1280–1282, Dec. 15, 1913.)—A redetermination of this constant [see Abstracts Nos. 1588 (1906), 1298 (1913)]. Godlewski's value 10·2 days is probably too low. Harn and Rothenbach find 11·6 days. The authors arrive at the value 10·85 days. E. E. F.

888. *Penetrating Atmospheric Radiation.* **W Kolhörster.** (Phys. Zeitschr. 14. pp. 1066–1069, Nov. 1, and pp. 1153–1155; Discussion, pp. 1155–1156, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien. Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1111–1116, Nov. 15, 1913.)—The apparatus used in three balloon voyages from Bitterfeld was a Wulf-Hess double-fibre electrometer closed air-tight, and the errors are estimated not to exceed 10 or 15 per cent. The measurements show an increase in the penetrating radiation with the height in all three voyages, but most of all in the first voyage, which passed over the (highly radio-active) Erzgebirge. The author believes this increase is not due to any known radio-active substance. In the *discussion*, **Gockel** mentioned having come to the same conclusion from measurements on glaciers. **Bergwitz** thought that the increase might be a temperature effect. But the **Author** replied that a temperature effect would be in the opposite sense to the effect observed. E. E. F.

889. *Helium in Coal-mine Gas and the Radio-activity of Coal.* **C. Moureu** and **A. Lepape.** (Comptes Rendus, 158. pp. 598–603, March 2, 1914.)—Mine gases, and especially blowers, contain quantities of helium, which are much greater than those found in mineral waters. The authors find that the Anzin blower yields 12 m.^{3} of helium daily, or 4380 m.^{3} annually; the Frankenholz blower yields, according to Guntz, 3650 m.^{3} per year, the gas outbreak at Neuengamme yielded, according to E. Czakò, even 25,550 m.^{3} of helium per year. The radio-activity of the mine gas proved too weak for determination. The quantities of radium and thorium in the coal estimated after R. J. Strutt and J. Joly (burning the coal and examining the ashes), yielded the following weights of radium (and thorium) expressed in 10^{-12} gm. per gm. of coal: at Liévin, < 0·02 (—); Anzin, < 0·01 (0·01); Lens, 0·97 (0·33); Frankenholz, 0·04 (0·03); Mons, < 0·01 (0·02). Calculations made for Frankenholz show that only a very small portion of the helium could have been produced by the radio-active elements in the coal. On the other hand, it is noteworthy that helium is, in mine gases and other natural gases, always accompanied by the other rare gases, neon, argon, krypton, xenon, which certainly could not have been produced in the coal. An estimate of the radio-active components in the rocks of coal-beds cannot account for the helium found either. H. B.

890. *Radio-activity of Japanese Mineral Springs.* **D. Isitani.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 221–225, Jan., 1914.)—The paper relates to the emanation content of eleven springs with temperatures varying from 18° C. to 91° C., the average content being about 400×10^{-12} curie per litre of water. E. M.

HEAT.

891. *Apparatus for the Determination of Gas Isotherms up to about 3000 Atmospheres.* **P. Kohnstamm** and **K. W. Walstra.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 754–769, Feb. 28, and pp. 822–825, March 28, 1914.)—The authors describe the essential features of the apparatus gradually evolved for the measurement of the pressures and volumes of gas under pressures as high as 3000 atoms. For the details of the apparatus and of the method of calibrating it, the original should be consulted. T. H. P.

892. *Calibration of Thermometers by Floating Equilibrium.* **T. W. Richards** and **J. W. Shipley.** (Amer. Chem. Soc., Journ. 36. pp. 1–10, Jan., 1914.)—By using a hollow float of quartz or glass immersed in a solution of known concentration it is possible to determine the temperature of floating equilibrium within about 0·001° C. These floats may therefore be used for the calibration of thermometers, when once the necessary relationship between temperature and concentration has been established.

In checking the weights of the floats it was found that difficulty in weighing arose in part from electrostatic effects, since the errors disappeared at once when a tube of radium bromide was present in the balance case. T. M. L.

893. *New Calorimetric Resistance Thermometers.* **H. C. Dickinson** and **E. F. Mueller.** (Bureau of Standards, Bull. 9. pp. 483–492, 1913.)—A general description of an improved form of calorimetric resistance thermometer is given, together with some points of interest in connection with its use. The essential features of such a thermometer, to which attention has been given, are enumerated. A difference formula for simplifying calorimetric computations is developed in the paper, and its applicability shown. F. J. H.

894. *Latent Heat of Fusion of Ice.* **H. C. Dickinson, D. R. Harper,** and **N. S. Osborne.** (Bureau of Standards, Bull. 10. pp. 235–266, 1913.)—After giving a brief review of previous determinations of the latent heat of fusion of ice, the authors describe in detail their investigation of this constant by two independent calorimetric methods. The first of these is the ordinary method of mixtures, the temperature measurements in which are made by means of sensitive Pt-thermometers [see preceding Abstract], and the corrections inherent in the method very carefully determined; the second is an electrical method, in which the electrical heating serves to reduce the usual calorimetric corrections to an almost negligible quantity by keeping the temperature of the calorimeter near that of its surroundings. The method of procedure was to cool the samples of ice prepared in the form of hollow cylinders containing from 100 to 500 gm. to either – 0·72° or – 3·78°, in specially constructed cryostats, weighing while at these temperatures, and then introducing them rapidly into the water of the calorimeter. The results of the determinations carried out on 92 specimens indicate that for commercial can ice, commercial plate ice, natural ice, ice frozen in the laboratory from air-free double-distilled water, and from double-distilled water containing air, all of which were very pure as indicated by electrical

conductivity tests, the heat of fusion is the same to within the limits of accuracy of the earlier determinations, viz. 1 part in 1000. Further experiments on the three commercial forms of ice fail to show differences greater than about 1 part in 5000. The mean of the final 21 determinations gives for the latent heat of fusion 79·68 cals., the calorie being that at 15° C. Five observations on ice contaminated with a mixture of ammonia, NaCl and $CaCl_2$ to the extent of about 1 part in 1000 give results about 1·4 % lower than for pure ice. F. J. H.

895. *The Ice Calorimeter. With Remarks on the Constancy of the Density of Ice.* **E. Griffiths.** (Phys. Soc., Proc. 26. pp. 1–14; Discussion, pp. 14–15, Dec., 1913.)—The author has redetermined the value of the constant of the ice calorimeter. The latter was placed in a Dewar vessel surrounded by ice, and heat was added electrically, the potential at the ends of the heating coil being determined by balancing against a known number of standard cadmium cells; the resistance of the heating coil being also determined. Assuming $J = 4·184$ and the e.m.f. of the standard cadmium cell at 20° to be 1·01830, the author finds the constant of the ice calorimeter to be 15·486 mgm. of mercury per mean calorie. The author has calculated from this result the latent heat of fusion of ice, and finds it to be 80·30 mean calories, a number higher by 0·7 per cent. than that most recently determined by Smith (viz. 79·77); a discrepancy which the author attributes to the presence of occluded water in the ice used by Smith. The author regards the evidence which has been adduced by various observers, in favour of ice having a variable density, as not being conclusive. In the *discussion*, **Callendar** pointed out the uncertainty in the author's calculation of the latent heat of fusion of ice owing to the uncertainty in the value for the density of ice. Taking the value 0·9167 for the density of ice (Barnes) instead of 0·9161 as employed by the author, the latent heat calculated would be 79·5 (approx.). A. F.

896. *Melting-point of Arsenic.* **R. Goubau.** (Comptes Rendus, 158. pp. 121–122, Jan. 12, 1914.)—Highly purified arsenic is found to melt at 817° and to possess a considerable vapour pressure even far below this temperature. T. H. P.

897. *Heat Resistivity of Carbon and Graphite.* **J. W. Richards.** (Amer. Electrochem. Soc., Trans. 24. pp. 109–112; Discussion and Communications, pp. 112–118, 1913. Metallurgical and Chem. Engin. 11. p. 575, Oct., 1913. Abstract.)—The paper describes briefly observations made by J. P. Stokes and A. D. Jamieson upon the heat resistivities of carbon and graphite. Two blocks are cut in such a way that when placed together they form a cube of 20 cm. side, having a central cubical cavity of 2·5 cm. side. Heat is supplied to the inside by a 1000-watt arc formed between electric-light carbons introduced through closely-fitting glass tubes. The temperature at a point 1 mm. from the surface of the central cavity is measured by means of an iron-nichrome thermo-couple. In calculating the thermal resistivity, the cube is considered to be split into six truncated square pyramids. The thermal resistivities of carbon (202° to 858° C.) and of graphite (240° to 420° C.) are found to be 86·8 and 8·69 degrees per watt respectively. The ratio of these, viz. 10 : 1, is considered to be a minimum since the temperature of the outside was measured at the centres of the faces, which were warmer than the corners. For purposes of comparison a number of investigations by other observers are briefly abstracted. In the *discussion*, the paper was severely criticised, chiefly in regard to the correctness of the measured temperature gradient. F. J. H.

898. *Some Aspects of Heat-flow.* **E. F. Northrup.** (Amer. Electrochem. Soc., Trans. 24. pp. 85–106; Discussion, pp. 106–107, 1913. Metallurgical and Chem. Engin. 11. pp. 572–574, Oct., 1913. Abstract.)—After dealing at some length with the analogies and dissimilarities between the flow of heat and of electricity and with the difficulties in measuring thermal conductivity as compared with electrical conductivity, the author describes new methods of measuring thermal conductivity which he has devised and which have been suggested by the electrical analogies. The following four methods of measuring electrical resistance are considered in their application to thermal problems: (1) Measurement of the fall of potential and current. (2) Comparison between the fall of potential along the specimen and that along a standard resistance. (3) Wheatstone's bridge method. (4) Kelvin double bridge method. The usual method of measuring thermal conductivity by measuring the quantity of heat flowing and the temperature gradient is analogous to method (1). In regard to the second method the author has applied it very successfully for measuring the thermal resistance of the surface of contact between two bodies. Two cylindrical copper rods 3·8 cm. in diam. were pressed together end to end and the temperature-fall in equal lengths of 10 cm., one of which included the contact, were measured and compared. In this way the thermal resistance of the contact was obtained in terms of that of the copper. The author considers that the extension of this method to the comparison of the thermal conductivities of two materials would meet with success. There is no exact thermal analogy to method (3), but the method devised by the author and applied by W. Eves [see Abstract No. 1228B (1913)] to the comparison of the thermal conductivities of various impregnating insulation compounds was suggested by it. With regard to the Kelvin double bridge method its application to the comparison of thermal conductivities is suggested, the potential leads in the electrical arrangement being replaced by thermo-couples which supply the current for the bridge. A zero method of comparing thermal conductivities is thus obtained. On account of the simplicity of the foregoing methods the author advocates the use of standards of thermal resistance in the same way that standards of electrical resistance are used; he also suggests the use of electrolytic copper as the standard of low thermal resistance and of a specified grade of alundum cement as the standard of high thermal resistance. F. J. H.

899. *Flow of Heat through Furnace Walls.* **I. Langmuir, E. Q. Adams,** and **G. S. Meikle.** (Amer. Electrochem. Soc., Trans. 24. pp. 53–76; Discussion and Communications, pp. 76–84, 1913. Metallurgical and Chem. Engin. 11. pp. 574–575, Oct., 1913.)—The quantity of heat conducted through a body of any shape is given by the formula, $Q = S\int_{T_0}^{T} k \, . \, dT$, where k is the conductivity, T_0 and T are the temperatures of the two faces of the body and S is a quantity, termed the shape factor, which has the dimension of length and which depends only upon the shape and size of the body. It is only in the cases of parallel plane surfaces, concentric cylinders, and concentric spheres, however, that a rigorous calculation of the shape factor can be made. In other cases certain simplifying assumptions must be made, so that the results are of limited accuracy only. However, by assuming, first, certain shapes for the isothermal surfaces, and secondly, certain shapes for the lines of flow of heat, the authors find it possible to get two expressions for the shape factor, the first of which gives values obviously too high and the

second values obviously too low; the two, however, lie between narrow limits. Also, very good approximate results can often be obtained by imagining parts of the surface of inflow and outflow of heat to be replaced by spheres or cylinders of equal area. In addition to the theoretical investigation on the above lines the authors have verified the formulæ by experiment, results lying between the upper and lower limits being obtained. The experimental work consisted in measuring the electrical resistance of a saturated copper sulphate solution containing 0·5 % by volume of sulphuric acid, this solution being contained in vessels made up of suitable copper and glass plates and having shapes similar to those for which calculations had been made. The shape factor was obtained from the electrical resistance by comparison with that of a standard decimetre-cube with two opposite sides of copper. The shapes chosen for test represented elementary parts of cubes, prisms, cylinders, planes, etc., and in each case by varying the depth of the electrolyte in the cell the effect of the proximity of edges and corners could be tested. The results of the investigation are summarised at the end of the paper and an example of the calculation of the shape factor in a specific case is given. The results differ considerably from those calculated by two approximate methods in common use. In a communication to the *discussion*, **E. F. Northrup** pointed out that the determination of the shape factor to such a high degree of precision is not of very great importance in such problems as the conduction of heat through furnace walls as many other uncertain factors of large relative importance are involved. The determinations should, however, be of great use in the important problem of determining experimentally the thermal conductivity of heat insulators. Formulæ are developed by means of which the temperature of any point in the material can be determined from the known temperatures of two other points in the case of parallel planes, concentric spheres or concentric cylinders. **J. W. Richards** pointed out that the experimental results of the paper really only apply to the very special case in which the inner and outer surfaces are isothermals. F. J. H.

900. *Calorific Effects of Joule and Siemens.* **L. Decombe.** (Journ. de Physique, 4. Ser. 5. pp. 116–126, Feb., 1914. Comptes Rendus, 158. pp. 938–941, March 30, 1914.)—The electronic theory applied to metals as developed by Riecke, Drude, and Lorentz on the one hand, and by J. J. Thomson on the other, is here utilised by the author for the purpose of interpreting the laws of electric and calorific conductivity. It is found to explain satisfactorily the reversible Peltier and Thomson effects, but certain difficulties are encountered with the Joule-effect. The similarity of the latter to that of Siemens is pointed out, and the author believes the point of view developed in the present paper to furnish the elements of a new theory of metals. Drude and Lorentz's electronic theory is examined in detail and the Peltier and Thomson effects are shown to be capable of easy explanation on it; for in a homogeneous metal the number of free electrons per unit volume is constant for a given temperature but variable from one metal to another. If then two metals be considered in contact at the same temperature, it is necessary, in order to satisfy the equation of continuity, to admit the existence of a thin transition layer in which the number varies very rapidly. This variation determines the appearance of an e.m.f. normal to the layer and capable of compensating the diffusion current which the heterogeneity of distribution tends, on the other hand, to establish. The positive or negative

work effected upon this e.m.f. by a current traversing the layer may therefore be identified with the Peltier-effect. In an analogous manner every variation of temperature in an homogeneous metal brings about an e.m.f., which thus explains the Thomson-effect. It is otherwise with the Joule-effect, for on Drude's exposition the mechanism is that at the instant of impact the electrons lose the excess of kinetic energy communicated by the field since the preceding impact. Now the electrons could only have given up this excess of kinetic energy to the neutral atoms of the metal, and the author gives a mathematical exposition to show that the nature of the impact, considered on purely kinetic grounds, is incapable of satisfying this condition. The second form of the theory developed by J. J. Thomson in his corpuscular theory of matter proceeds from an entirely different standpoint, and is next examined by the author. In this theory electrons are expelled from each atom by the action of surrounding atoms, which latter are comparable to doublets formed of negative electrons and suitable positive charges. Moreover, every expelled electron is supposed to be immediately captured by a neighbouring atom. When the axes of the doublets are in every direction, no current exists since the flux of electrons from the reciprocal exchanges is not specifically orientated. If, on the other hand, the doublet directions be more or less completely polarised by an external field, there will be, parallel to the field and in a contrary sense, an excess of moving electrons which constitute the current. The present author now finds that J. J. Thomson's theory will give indirectly an interpretation of Joule's effect as well as directly that for Peltier and Thomson. He assumes that the phenomena of metallic and electrolytic conduction take place through the successive liberation and recombination of electrons or ions, and that there result changes in the final speeds which disengage heat. This heat evolution is a consequence of a special atomic viscosity bound up with fluctuations in the orbital movement of the electrons.

The present paper is a development of this point of view, the atom being regarded as a complex of small orbital electron systems called by the author "spectrons." Each electron liberated is immediately captured by a neighbouring spectron as in J. J. Thomson's theory, but the mechanism of expulsion differs from that proposed in the latter theory in that it is assumed as due to the electric field and not to the influence of neighbouring spectrons, so that in the absence of the field atomic dissociation is non-existent. During the action of the field, and only then, may each spectron be regarded as an electric doublet having its axis parallel to the field. The author then demonstrates how the fundamental laws and the various effects are directly established on this theory. Finally he puts forward suggestions based on this standpoint for a new theory of metals which shall satisfactorily interpret thermal conductivity and the effects of Peltier, Thomson, Hall, etc. H. H. Ho.

901. ***Constants of Spectral Radiation of a Uniformly Heated Enclosure.*** **W. W. Coblentz.** (Bureau of Standards, Bull. 10. pp. 1–77, Jan. 15, 1914.)—The present paper gives data relating principally to the determination of the mathematical form of the isothermal spectral curve of a black body, and to the computation of the numerical value of the constants relating thereto, for the temperature-range between 450° and 1525° C. The paper also contains data on various subsidiary problems such as (i) the variations of the reflecting power of silver with angle of incidence and with wave-length, (ii) the variation of the reflecting power of fluorite with angle of incidence and with wave-length, (iii) data on the most reliable refractive indices of fluorite, reduced to

20° C., and (iv) data for reducing the observations from prismatic to normal spectrum. The spectrum was produced by means of a mirror spectrometer and a fluorite prism. A vacuum bolometer was used for measuring the partition of energy in the spectrum. The radiator was a porcelain tube, wound with Pt-ribbon through which an electric current was passed. In a brief summary the results of previous investigations made with similar apparatus are discussed. It is shown that by the elimination of certain errors in the calibration of the prisms used, the older observations are not in disagreement, as was supposed from the published results. These older data (properly weighted) are therefore used in connection with the present-day results, to form an estimate of the most probable value of the constants of spectral radiation. The results obtained in the present investigation are based upon experiments with different bolometers, water-cooled shutters, fluorite prisms, thermo-couples, and radiators (blackened and unblackened). The success attained is attributed to blackening the radiator, to properly insulating the thermo-couples within the radiator, to placing a knife-edge support beneath the inner radiator to prevent it sagging, and to projecting an image of the radiating diaphragm upon the spectrometer slit. It is shown that the percentage of the total number of energy-curves which fit the Planck equation is increased by blackening the radiator. About 75 % of the reliable energy-curves fit the Planck equation, the validity of which was assumed in order to compute the radiation constants from the observed data. This involves a temperature-range greater than 1000°. Within this temperature-range there is a tendency for the constants to increase slightly with temperature, in several sets of observations, but this slight variation is not sufficiently systematic to be considered an actual departure from the theoretical (Planck) law upon which the computations are based. The mean values deduced from eight sets of observations (including 94 of the best spectral energy curves) are $C = 14{,}456 \pm 4$ mikron deg., $A = 2911 \pm 1$ mikron deg. The weighted mean value of the results of Lummer and Pringsheim, Paschen, Coblentz, and Warburg is $C = 14{,}420$ and $A = 2905$. As a result of the calibration of the thermo-couples used it was later found that the above mean value ($C = 14{,}456$) should be increased to $C = 14{,}465$. The latest results of Hoffmann and Meisner on the ratio of brightness of two black bodies at the melting-points of gold and of palladium, using an optical pyrometer, gives a value of $C = 14{,}440$. The value now commonly used is $C = 14{,}500$, and from present indications there appears to be no immediate need to adopt a new value. [See also Abstract No. 640 (1913).] A. W.

902. *Theory of Specific Heat.* **D. A. Goldhammer.** (Phys. Zeitschr. 14. pp. 1185–1189, Dec. 1, 1913.)—Gives a simplified method of evaluating the number of proper frequencies of isotropic and æolotropic bodies within a certain interval of frequency. It is based upon the method used by Rayleigh and by Jeans (1905) for elastic bodies in the theory of radiation. The final formula represents a generalisation of Debye's formula which makes it applicable to crystals. E. E. F.

903. *Specific Heat.* **M. Trautz.** (Phys. Zeitschr. 14. pp. 1176–1178, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—Attempts to work out a "chemical" theory of specific heat which shall account for the low values obtained at low temperatures and agree with the quanta theory. Gases are taken as constituted by a large but finite number of isomers of the same molecular weight, which change into each

other at a very rapid rate, even down to absolute zero. In the case of H and N the assumption of only two isomers of constant molar heat 3/2R and 5/2R gives a close agreement with observation as regards heat of transformation, dissociation, the integration constant, and other constants. It yields a quantitative and very graphic interpretation of the rise of chemical affinity with temperature. The view of anomalous specific heat is much like that of anomalous vapour pressures with which we are already familiar. E. E. F.

904. *Space-lattice Vibrations and Specific Heats of Solids.* I. **H. Thirring.** (Phys. Zeitschr. 15. pp. 127–133, Feb. 1, 1914.)—The quanta theory, in the works of P. Debye, of Born, and of v. Kármán, has furnished relations between the specific heats of solids and their elastic constants which so far seem satisfactory. This line of thought is here worked out mathematically for substances with diatomic molecules such as rock-salt. [See Abstracts Nos. 446, 626 (1913), 266 (1914), and next Abstract.] E. H. B.

905. *Space-lattice Vibrations and Specific Heats.* II. **H. Thirring.** (Phys. Zeitschr. 15. pp. 180–185, Feb. 15, 1914.)—The theory of Born and Kármán for space-lattice vibrations is extended to lattices in which different masses alternate; this enables one to calculate the relation between the elasticity and the specific heat at low temperatures for regular crystals with more than one atom in the molecule. The calculation is carried out for NaCl, KCl, CaF_2, and FeS_2. The results show a mean deviation of 2·3 % and a maximum of 4 % from the observed values. [See preceding Abstract.] E. H. B.

906. *Combustion of Gaseous Mixtures and Velocities of Reaction.* **Taffanel.** (Comptes Rendus, 158. pp. 42–45, Jan. 5, 1914.)—Theoretical considerations dealing with the results previously obtained [see Abstracts Nos. 280, 281 (1914)]. T. H. P.

907. *Vapour Pressure of Metallic Tungsten.* **I. Langmuir.** (Phys. Zeitschr. 14. pp. 1273–1280, Dec. 15, 1913.)—Shows that the vapour pressure p of a substance is connected with its rate of evaporation m in a vacuum by the equation $m = (M/2\pi RT)^{\frac{1}{2}} p$, where M is the molecular weight of the vapour. In deducing the equation, it is assumed that all molecules of a metallic substance impinging on the surface of the metal are condensed, and none reflected. Experiments to determine the rate of evaporation of tungsten were made at temperatures ranging from 2440° to 3186° abs. Within that range the rate of evaporation increased in the ratio of 1 : 15000. The vapour pressure thus found agrees excellently with the thermodynamic formula of Clausius and Clapeyron. The heat of vaporisation for 184 gm. of solid W is thus (21780 − 1·8 T) cals. This is greater than the heat developed in any chemical reaction. The rate of evaporation of tungsten in a perfect vacuum at a temperature T is given accurately by the equation $\log m = 15{\cdot}402 - 47440/T - 1{\cdot}4 \log T$, m being reckoned in gm. per cm.^{2} and sec. The vapour pressure of tungsten in mm. of Hg at temperature T abs. is given by $\log p = 15{\cdot}502 - 47440/T - 0{\cdot}9 \log T$. The vapour pressure of tungsten at 2400° abs. (the temperature of the filament in a lamp giving 1 c.p. per watt) is about 50×10^{-9} mm. At the melting-point of tungsten, 3540° abs., the vapour pressure is 0·080 mm. The boiling-point of tungsten at atmospheric pressure is probably close to 5100° abs. At 2000° abs. it is $6{\cdot}45 \times 10^{-12}$ mm. E. E. F.

908. *Absolute Zero Entropy-Changes on Mixing.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 669–673, Jan. 29, 1914. Comm. Phys. Lab., Leiden, Supplement No. 33. Phys. Zeitschr. 15. pp. 217–220,

March 1. *Erratum*, p. 868, April 1, 1914.)—According to Planck's version of the Nernst heat theorem the entropy of a one-component substance in a condensed state approaches to a finite value, which is independent of the pressure and of the special state of aggregation, when the absolute temperature approaches to 0. That value may be taken as a suitable zero-point for the entropy of that substance in the condensed state. General considerations are shown to suggest that for a mixture also the entropy at the absolute zero-point is equal to 0, if this is the case for the components, by the choice of this point as a zero-point for the corresponding entropies. According to a remark by Nernst [Abstract No. 682 (1913)] the equipartition law fails in an ideal gas approaching zero, so that the temperature is not determinable by a gas thermometer, but may be determined theoretically from the energy density of the radiation in equilibrium with it. Calculation on the assumption that the molecular volume does not become infinite for $T = 0$ confirms the above conclusion by showing that at the absolute zero the entropy-change on mixing two ideal gases is equal to 0. Further confirmation is obtained mathematically from relations for the equation of state in an ideal gas obtained by the author in a former paper [Abstract No. 288 (1914)]. G. W. de T.

909. *Wien's Radiation Formula from the Assumption of Independent Light-quanta.* **G. Krutkow.** (Phys. Zeitschr. 15. pp. 133–136, Feb. 1, 1914.)—It is here shown mathematically that Wien's radiation formula (and not Planck's) follows from the two following assumptions:—

I. A resonator of the frequency ν can only possess energy of the values, 0, $h\nu$, $2h\nu$....

II. These energy values are formed by the juxtaposition of elementary amounts of energy $h\nu$, which are independent of each other. [See Abstracts Nos. 1562 (1905), 445 (1914).] E. H. B.

910. *Note on the Heat of Formation of Hydrogen from Hydrogen Atoms.* **I. Langmuir.** (Phil. Mag. 27. pp. 188–189, Jan., 1914.)

911. *Kinetic Theory of Perfect Gases.* **E. Bouty.** (Journ. de Physique, 4. Ser. 5. pp. 5–16, Jan., 1914.)—Discusses on the kinetic theory the equilibrium of a perfect gas under gravity, and thus obtains for the height of the atmosphere the usual formula $h = \gamma/(\gamma-1) . RT_0/g$. E. H. B.

912. *Boltzmann Theorem and Energy Quanta.* **P. Ehrenfest.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 591–597, Jan. 29, 1914.)—A mathematical discussion of the legitimacy of the mixture of classical and non-classical mechanics which occurs in connection with a mechanical theorem of Boltzmann and the energy quanta of Planck. E. H. B.

913. *Natural Vibrations and Specific Heats.* **M. Born.** (Phys. Zeitschr. 15. pp. 185–191, Feb. 15, 1914.)—A mathematical discussion of these problems on Planck's theory. [See Abstracts Nos. 626 (1913), 19 (1914).] E. H. B.

914. *Undamped Vibrations and Planck's Radiation Theory.* **C. W. Oseen.** (Ann. d. Physik, 43. 4. pp. 639–651, Feb. 27, 1914.)—A mathematical discussion of the possibility of the existence of undamped vibrations on Maxwell's theory, and with reference to Planck's radiation theory. [See Abstract No. 1826 (1913).] E. H. B.

915. *Derivation of the Canonical Form of the Equation of State from Statistical Mechanics.* **A. Wassmuth.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 651–666, March, 1913.)—Mathematical. Supplementary to the work of Ornstein and of Planck [Abstract No. 1455 (1908)].

SOUND.

916. *Range and Sharpness of Resonance and their Variations with Pitch.* **E. Waetzmann.** (Phil. Mag. 27. pp. 467–468, March, 1914.)—The author entirely agrees with E. H. Barton [see Abstract No. 1701 (1913)] as to the distinction between coefficient of damping and logarithmic decrement, but also points out that in respect to the ear he had already recognised this (E. Waetzmann, "Die Resonanztheorie des Hörens als Beitrag zur Lehre von den Tonempfindungen," Braunschweig, 1912; Bemerkung über die Dämpfung der Ohr-resonatoren, Schlesisch. Gesell. Sitzung vom 28 Mai, 1913). Whereas Helmholtz in his theory of hearing assumes that all the resonators of the ear have the same logarithmic decrement—that they have, therefore, disregarding certain negligible factors, the same sharpness of resonance—the author has suggested and critically examined the hypothesis that it is not the logarithmic decrement, but rather the damping coefficient of all the resonators of the ear for the ordinary compass of the audible scale, which remains approximately the same. In working out this theory, the author had calculated quantitatively the dependence of the sharpness of resonance on the proper frequency of the resonator, and found that known facts agree better with this theory than with that of Helmholtz. E. H. B.

917. *Recording of Acoustic Vibrations by means of Wulf's String Electromotor.* **G. Gianfranceschi.** (Accad. Lincei, Atti, 22. Part II. pp. 216–221, Sept. 7, 1913.)—The method adopted was to use a microphonic transmitter connected in series with the primary of a large induction coil without interrupter, the secondary terminals being connected to the electrometer and to earth respectively. A number of oscillograms are given showing the vibrations corresponding to the five vowels sung upon the same note (c''). Further results are to be published, the present being a preliminary account. L. H. W.

918. *Enlargement and Reduction of Gramophone Records.* **G. A. Le Roy.** (Comptes Rendus, 158. pp. 175–177, Jan. 19, 1914.)—Describes a method by which discs or cylinders may be enlarged or reduced. A cast or matrix is taken by copper deposition and then an aqueous solution of gelatine is used for enlargements. Other and various substances are used for reductions. The changes of size desired are obtained by successive small stages in the elastic material. A photographic reproduction shows an enlarged and a reduced disc, one double the diameter of the other, and both derived from the same original. E. H. B.

919. *Aural Illusion.* **N. Alliston.** (Nature, 92. p. 61, Sept. 18, 1913.)—If a sounding body had a velocity greater than that of sound in air, it would outstrip its previous sounds as it went, and leave them to follow in its wake. Suppose such a body ceased sounding on passing an observer. Then the sounds last emitted would be heard first and heard loudest because the body was so near when emitting them. In such circumstances, therefore, it would seem to the observer that the source of sound had been receding instead of approaching. This is quite distinct from the Doppler-effect on the pitch.

E. H. B.

920. *Whispering Galleries.* **Rayleigh.** (Phil. Mag. 27. pp. 100–109, Jan., 1914.)—The author here further applies Bessel's functions of high order to the whispering gallery and allied problems. The analysis confirms the expectation that the whispering-gallery effect does not require a perfectly reflecting wall, but that the main features are reproduced in transparent media, provided that the velocity of waves is moderately larger outside than inside the surface of transition, and further, the less the curvature of this surface the smaller is the refractive index (greater than unity) which suffices. E. H. B.

921. *Air-pressures used in Playing Reed Instruments.* **C. W. H. Foord.** (Phil. Mag. 27. pp. 271–277, Feb., 1914.)—In W. H. Stone's work, "Elementary Lessons on Sound," a table is given showing the maximum and minimum wind-pressures used in playing various instruments. This table gave for the clarinet 15 in. to 8 in. of water-pressure. For each of the other instruments, the oboe, bassoon, horn, cornet, trumpet, euphonium, and bombardon the pressures given occur in the opposite order, the lower ones occurring first. It was shown by E. H. Barton and S. C. Laws that for the cornet, trumpet, and trombone the higher pressures are for higher notes [see Abstract No. 1534 (1902)]. The question accordingly arose, Is the clarinet unique in this respect? or, Was the 8 a misprint for 18, as assumed by some writers? The present author has settled this point by a series of experiments which show that as the pitch of the notes rises in the clarinet the pressure usually falls. Thus on the B♭ clarinet played *forte* 15·5 in. of water was used for the lowest note (E) and 9·5 for the G♯ more than three octaves higher. Playing *piano*, the pressures ranged from 6·5 to 4·25. The pressure curves for the clarinet show a slight rise with pitch fo rabout a tone near the middle of the compass succeeded by a fall to the extreme limit.

On the E♭ saxaphone played with a single reed the pressure is greatest near the middle of the compass, falling off slightly at top and bottom. The E♭ saxaphone played with a double reed showed higher pressures for the higher notes. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

922. *Mass of Moving Electrons.* **C. Schaefer** and **G. Neumann.** (Phys. Zeitschr. 14. pp. 1117–1118, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—The authors repeated Bucherer's experiments concerning the dependence of mass upon speed [Abstract No. 1993 (1908)] which were claimed as a confirmation of the Lorentz-Einstein principle of relativity, but criticised by Bestelmeyer [Abstract No. 1549 (1911)]. The new results completely confirm Bucherer's work, and decide the question of Abraham's as against Lorentz's electron in favour of the latter. E. E. F.

923. *Free Electrons in Metals.* **K. F. Herzfeld.** (Phys. Zeitschr. 14. pp. 1119–1121; Discussion, pp. 1121–1122, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—The number of free electrons in metals has been estimated (*a*) from the conductivity and probable free path; (*b*) from the reflective power; (*c*) from the Hall-effect; and (*d*) from the current obtainable from incandescent solids. All those methods give fairly concordant results, indicating a number amounting to about 1/3 of the number of metallic atoms. But that raises a difficulty regarding the specific heat of electrons, which ought to produce a difference between conductors and insulators as regards Debye's formula. The author attempts a new calculation from the entropy constant, regarding the dissociation of electrons as an "evaporation" from the molecules, and using Stern's method, which does not involve quanta. This reasoning makes the number of electrons about 1/600th of the number of atoms. The author acknowledges that the reasoning is not free from objection, but urges that all the other methods are equally open to criticism. E. E. F.

924. *Pulsating Electrons and Quanta.* **A. Korn.** (Phys. Zeitschr. 14. pp. 1109–1112, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—Points out that the main difficulty in the hydrodynamical analogies of electromagnetic phenomena, viz., that of the attraction between quantities of the *same* sign, may be overcome by postulating a fundamental individual, permanent, and characteristic rate of pulsation for the electrons or other ultimate elements. The energy of this pulsation may be called the "pulsation quantum." The author suggests that d'Alembert's principle may be usefully supplemented by a principle of "the conservation of individuality" as regards fundamental frequency. The frequencies are of a higher order than those familiar to us in optical and electrical theory.

The permanence of atoms may be more safely based upon frequency than upon geometrical shape. E. E. F.

925. *Corpuscular Radiation.* **H. Bateman.** (Phil. Mag. 26. pp. 579–585, Oct., 1913.)—Mainly a study of one type of electromagnetic field having as its chief characteristic a corpuscular type of radiation. Mathematical. L. H. W.

926. *Specific Inductive Capacities of Liquids.* **C. Gutton.** (Comptes Rendus, 158. pp. 621–623, March 2, 1914.)—If, as Voigt suggested, the force acting on an electron in an electric field were not exactly proportional to its

displacement, the value of the specific inductive capacity would undergo variation with the strength of the field. The author has examined the specific inductive capacities of various liquids by using them as insulators in a condenser forming part of a resonating circuit. This circuit was made to respond to the electric oscillations in Blondlot's arrangement of two parallel wires joined together at any point by a cross-wire. The currents in the resonator circuit were measured by a galvanometer and the distance between the two positions of the cross-wire for which the oscillations in the resonator were a minimum gave the half-wave-length to which the resonator was tuned. This being proportional to the square root of the specific inductive capacity of the liquid in the condenser, it was found that on increasing the intensity of the waves in the ratio 1 : 10 the wave-length remained (within the limits of experimental error) constant for toluene or CS_2, while in the case of liquids of greater specific inductive capacity, such as bromonaphthalene, there was a slight diminution. The specific inductive capacities found were, at 15° C.: toluene 2·36; CS_2 2·61; bromonaphthalene 4·72 to 4·69.

J. W. T. W.

927. *A New Form of Electric Wind.* **S. Ratner.** (Comptes Rendus, 158, pp. 565–567, Feb. 23, 1914.)—It is generally known that in strong electric fields the intense ionisation by collision is accompanied by a motion of the gas itself. Some strange effects observed in connection with the recoil of radio-active atoms have led to the revelation of the same phenomenon in other cases of conduction in an ionised gas. This fact, which is of considerable importance, since it probably affects measurements in radio-activity generally, can be made evident by a simple experiment. To one plate of an air condenser is attached on the inside a small plate coated with radio-active material to ionise the air. The other plate is earthed and carries a metal tube perpendicular to it, having at its outer end a small suspended vane. By reason of the air current set up by the motion of the ions this vane becomes deflected as soon as the condenser is charged. The arrangement is very sensitive, an ionisation current of 10^{-10} amp. being sufficient to cause an appreciable deflection. The following facts have been observed in connection with the air-current:—The force exerted on the vane is larger for the positive ions than for the negative, the difference between the two being greater the smaller the distance between the plates; it is roughly proportional to the amount of ionisation. For small fields the force is proportional to the intensity, but as the field increases the force increases to a maximum and then gradually diminishes. When the plates are near together and the condenser is charged negatively, a negative deflection is obtained, indicating that a current of air is then passing into the condenser. The difficulties experienced by several observers in their work on the motion of radio-active atoms in an electric field are undoubtedly due to the above phenomenon.

F. J. H.

928. *The Electrification of the Atmosphere, Natural and Artificial.* **O. Lodge.** (Inst. Elect. Engin., Journ. 52. pp. 333–344; Discussion, pp. 344–348; Appendix, pp. 348–352; March 2, 1914. Fifth Kelvin Lecture. Electrician, 72. pp. 892–895, March 6, 1914. Abstract.)—The first part of the paper contains a survey of the present position of our knowledge of atmospheric electricity and refers to the connection of Kelvin with this branch of science. The latter, as a result of his observations, formed the opinion expressed as follows: "The common fair-weather condition, I am forced to conclude, is due to a paramount influence of positive electricity in the higher regions of the air."

Lodge inclines to the same belief, and hopes that it may thus in the future be possible to effect some control over the weather by means of the electrification of the atmosphere. The main part of the paper is devoted to a consideration of the electrification of crops and its effect. A great deal of practical work has been done in this direction, and it has been proved that in many cases beneficial results may be expected from the treatment. It has been found that a suitable degree of electrification can be produced by a light network of wires supported on as few poles as one to the acre, and that a 2-h.p. engine will maintain the network at the necessary potential for a good-sized field, so that the expense of installing the plant is not unreasonably large. Voltages up to 100,000 have been employed in the experimental work. The results indicate that the most benefit is obtained in sunless years; that is, the electrification may be regarded as to some extent taking the place of sunshine. It also appears that the crops require plenty of water to obtain full benefit from the treatment. In the work done in the past the wire network has generally been charged so as to increase the intensity of the normal fine-weather potential gradient, but there is room for further experiment in the use of a strong negative gradient. The most complete experiments yet made are those carried out on wheat at Bevington, in Worcestershire. Over a period of 7 years an average increase of yield of over 25 % was recorded between the treated plot and the control plot. In seconding the vote of thanks to the lecturer, **S. P. Thompson** alluded to the great rapidity with which crops grow in the short summer of the Arctic regions, and suggested that the cause might be electrical and connected with the aurora borealis. An appendix to the paper contains a good deal of data bearing on the results already achieved in the application of electrical treatment to plants. J. S. Di.

929. *Electric Charge of Rain.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 14. pp. 1287–1292, Dec. 15, 1913.)—The authors put forward a modification of the influence theory of thunderstorms advanced by them in 1885. Instead of assuming a separation of a small drop from a larger one on the upper surface of the latter, they suppose it to take place at the lower surface. This implies that the potential gradient is opposite to the sign of the charges of the drops. E. E. F.

930. *Electric Charge of Rain.* **F. Schindelhauer.** (Phys. Zeitschr. 14. pp. 1292–1296, Dec. 15, 1913.)—A reply to G. C. Simpson [Abstract No. 710 (1914)]. The author maintains that the theory ascribing atmospheric electricity solely to the disintegration of drops does not account for the electrification of snow, which shows phenomena not essentially different from ordinary thunderstorms. He prefers some kind of influence theory of thunderstorms. E. E. F.

931. *Simultaneous Observations of Penetrating Atmospheric Radiation.* **H. Benndorf, Dorno, Hess, v. Schweidler,** and **T. Wulf.** (Phys. Zeitschr. 14. pp. 1141–1143; Discussion, pp. 1143–1144, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—Simultaneous observations of the penetrating radiation in the atmosphere were taken in Graz, Davos, Vienna, Innsbruck, and Valkenburg (Holland) once a week for several weeks by means of Wulf's electrometer. In Vienna and Davos two instruments were used, which showed the same behaviour. But there was no connection between the indications at different places, which shows that the fluctuations are not of cosmic origin. E. E. F.

DISCHARGE AND OSCILLATIONS.

932. *Flame Couples.* **G. Moreau.** (Comptes Rendus, 158. pp. 260–262, Jan. 26, 1914.)—Several substances, particularly chlorine and bromine, possess the property of modifying considerably the e.m.f. of flame couples. The series bare Pt—pure flame F_1—pure flame F_2—Pt covered with the oxide of an alkaline earth has an e.m.f., according to the oxide used, of from 0·55 to 0·70 volt, the electrodes being at 1400° abs. [see Abstract No. 517 (1914)]. If into the flame F_1 bromine water is sprayed, the e.m.f. increases with the concentration of the bromine in the flame up to a maximum which is about 0·55 volt higher than the initial value, which is regained as the flame becomes pure again. With chlorine, chloroform, and carbon tetrachloride similar effects are obtained. For the mixed series bare Pt—salted flame F_1—pure flame F_2—Pt covered with oxide [*loc. cit.*], analogous results are obtained on introducing the active substance into flame F_1, the increase of e.m.f. in all cases being about 0·55 volt. The series cold Pt—pure flame—hot Pt has an e.m.f. of 0·55 volt, given by $E = I_P/e$, where I_P is the mean normal kinetic energy of a corpuscle of charge e leaving the hot Pt. The effect of the active substance introduced into the flame F_1 is to annul this e.m.f., and hence the e.m.f. of the flame couple is increased by the same amount. A. W.

933. *Ionisation by Positive Ions.* **E[va] v. Bahr** and **J. Franck.** (Deutsch. Phys. Gesell., Verh. 16. 1. pp. 57–68, Jan. 15, 1914.)—It is known that positive ions with high velocities are strong ionising agents. Little is known, however, as to the ionising power of positive ions moving with small velocities, and conflicting estimates have been given for the value of the minimum voltage through which a positive ion has to fall in order that it may acquire a velocity sufficient for it to ionise molecules with which it collides. After discussing the work of Townsend and others upon the subject, the authors proceed to describe experiments similar to those on electrons by Franck and Herz [Abstract No. 659 (1913)] in which an attempt it made to ascertain the minimum voltage in the case of positive ions. As sources of these an incandescent Pt-wire, either bare or coated with aluminium phosphate, was used. This lay along the axis of a cylindrical Pt-cage. The positive ions were sent by means of an applied field through the surrounding cage into the annular space beyond, where they encountered a reverse field which sent them back to the cage. The ionisation produced in the annular space was measured by the current of negative ions passing through that space to an outer Pt-cylinder. The results obtained show, as was supposed, that positive ions are much weaker ionising agents, under these conditions, than electrons. No definite ionisation voltage can be given from the experimental curves, but if such exists it must lie both with air and with hydrogen below 6 volts, which is less than that for electrons. Various possible theoretical explanations are discussed, but owing to certain inherent difficulties as to the precise nature of the ions used, the velocity of emission of the ions, etc., the results must be taken as of a preliminary character only.

Further work is contemplated. F. J. H.

934. *Ionisation by Heated Metals.* **H. J. Proumen.** (Bull. Soc. Chim Belg. 27. pp. 295–300, 1913.)—Metals emit positive and negative ions when moderately heated (135° to 145° C.) in a dry atmosphere of filtered air, but there is a fatigue after some time which may last a long period. Measurements were made with a Dolezalek electrometer. The experiments were made with an externally oxidised spiral of brass, with rusty nails, clean nails, and with other clean or tarnished metals. The amount of gas liberated was very variable. The gas, the author considers, is occluded in the surface layer or between the surface layer of oxide or sulphide and the metal underneath; when the gas-bubbles have found an outlet, no further fractures are produced by heating, and fatigue sets in. Ions may also be formed by slow oxidation and be occluded between the surface layer and the metal until liberated by heat. The chemical influence of surface layers is to be investigated. H. B.

935. *Positive Ions from Hot Metals.* **O. W. Richardson.** (Roy. Soc., Proc. Ser. A. 89. pp. 507–524, Feb. 2, 1914.)—Further experiments were made with the object of discovering the precise nature of the positive ions emitted from metals when they are first heated [see Abstracts Nos. 117 (1909), 118 (1911)]. Determinations of m/H, the electric atomic or equivalent weight, are carried out as before, but the apparatus is considerably modified in a number of details so as to ensure higher accuracy, since the earlier observations were not sufficiently exact to determine with certainty whether the ions are atoms of Na or K or are molecules of some of the commoner gases, such as CO, the electric equivalent of these substances not being widely different. With the modified form of apparatus either the slit or the balance method can be used simply by changing the connections outside the tube [Abstract No. 132 (1914)]. The results of a number of experiments with strips of Pt, iron, and manganin gave values of m/H very close to 40 during the first 36 hours of heating; after this values which fell fairly rapidly to about 24 were obtained. The value 40 is exactly the same to within the limits of experimental error as that obtained with a strip coated with K_2SO_4, which has been previously shown by the author to emit positive K-ions [see Abstract No. 258 (1911)]. It thus appears that during the first stages of the heating, K-ions are emitted, after which an emission of Na-ions takes place. In the discussion of this result, the more important experimental observations which tend to support the view that the ions emitted are charged atoms or molecules of one or more of the commoner gases are enumerated and each dealt with in turn. Platinum strips treated in various ways were always found to give the same value of m/H, and the fact that putting the strip under mechanical strain causes the positive emission to be considerably increased leads the author to suggest that mechanical disturbance is in most cases the cause of the renewal of the emission after the metal has been glowed out and then subjected to some treatment or other. The author does not believe the question to be settled beyond the possibility of doubt, but the balance of evidence at present available favours the view that the emission from the various metals is due to the presence of potassium and sodium as common impurities. The amount of these present, however, according to an approximate calculation of the total emission is insufficient to be rendered evident by any chemical test. F. J. H.

936. *Selective Action of Metals in the Photoelectric Effect.* **G. Reboul.** (Comptes Rendus, 158. pp. 477–479, Feb. 16, 1914.)—Pohl and Pringsheim have shown that a selective photoelectric effect on metals exists. This selective action can be easily proved by the method described, and, at the same time, it is shown that the radiations producing the max. negative emission are those which the metal absorbs most easily. Use is made of the fact that an extremely thin layer of silver is transparent to ultra-violet light. The luminous

source used is a quartz mercury lamp. If the radiations most strongly absorbed are those which call forth by their incidence upon the lamina of silver the max. photoelectric emission, then the light after filtration should produce a relatively more feeble photoelectric effect with silver than with other metals. Experimental details are given, and the results obtained show that light filtered through silver always produces a relatively smaller effect with that metal. It is also shown that, except in the cases of Al and Zn, the series of metals calculated from Lindemann's formula is nearly identical with the series obtained by comparing the emission with a filtering lamina of transparent quartz with that obtained when using a silvered quartz filter.
A. E. G.

937. *Discharge-tube Oscillograph.* **H. Greinacher.** (Elektrotechn. Zeitschr. 35. pp. 212–213, Feb. 19, 1914.)—If two wires are arranged in a vertical plane in such a way that the distance between them is greater at the top than at the bottom, and are connected to a high-voltage transformer or to an induction coil, an arc is produced which, starting at the narrow end, travels up the wires. This phenomenon repeats itself indefinitely, the arc taking somewhere about a second to travel up the wires. The nature of the discharge is not revealed by a visual observation of this phenomenon. If, however, the wires are arranged in a vacuum tube, provided the gas pressure is suitable, the character of the discharge is beautifully demonstrated. A series of blue streamers, the kathode-glows, issue from each wire at regular intervals, these being interspaced by points of light which are the anode-glows. These tubes are thus self-contained oscillographs which, besides giving information respecting the character of the current, can also be used for a variety of quantitative purposes, such as the determination of the frequency of a current interrupter or, if run by an alternating current of known frequency, the measurement of the speed of a photographic shutter.
F. J. H.

938. *Absorption of Light inside Quartz Mercury Lamps.* **F. P. Kerschbaum.** (Zeitschr. Instrumentenk. 34. pp. 43–47, Feb., 1914. Electrician, 72. pp. 1074–1076, April 3, 1914.)—Discusses the absorption of the light from the (central) most luminous part of the discharge by the surrounding mercury-vapour, and describes a lamp in which the effect is reduced considerably. The lamp is water-cooled, and is provided with an electromagnet which is used to deflect the intenser part of the discharge to the wall of the tube. Thus an increased intensity of emission is obtained. A resonance lamp is also described, giving practically pure monochromatic light of wave-length λ2536. [See also Abstract No. 1607 (1906).] A. W.

939. *Thermic Emission of Electrons and Photoelectric Effect of Potassium.* **K. Fredenhagen.** (Deutsch. Phys. Gesell., Verh. 16. 5. pp. 201–219, March 15, 1914.)—The author has previously developed the theory that the photoelectric effect with metals is in some manner dependent upon the presence of gas, and that metals, when entirely freed from gas, do not exhibit the normal photoelectric effect. Küstner's experiments with Zn [Abstract No. 717 (1914)] which were published at the same time seemed to give support to this theory. It is now shown that in the case of potassium the emission of electrons obtained by heating is not due to the K itself. Some agent, probably a gas, capable of bringing about this phenomenon exists and can be driven out of the metal or by other means put out of action. Several methods of proving this point are dealt with. It is further shown that He, Ar, and N_2 cannot produce the effect. There appears to exist some connection between the emission of electrons due to heating K and its photoelectric behaviour, since both effects are diminished as the result of the same operations. It is shown that potassium can exhibit a photoelectric effect with and without temperature coefficients, according to the kind of treatment it undergoes. It would seem that the active agent both for the thermic and the photoelectric emission of electrons is hydrogen, but no direct proof of this is obtained. Further experiments are necessary before any definite conclusions as to the causes of the phenomena can be arrived at. A. E. G.

940. *Influence of Diameter upon the Potential-difference at the Terminals of Neon Tubes. Observations Relative to the Aurora Borealis.* **G. Claude.** (Comptes Rendus, 158. pp. 479–482, Feb. 16, 1914.)—It has been shown that with equal current density the fall of potential along the luminous column of neon tubes acting under a pressure of about 2 mm. Hg is practically inversely proportional to the diam. of the tube [Abstract No. 1994 (1913)]. In the present experiments the limits of operation are extended and the fall of potential at the extremities of the luminous column is measured directly instead of deducing the total p.d. as was formerly done. For this purpose the new tubes are furnished with large Pt-wires which penetrate to the luminous column and are placed at some cm. from the principal electrodes. The results represented graphically show that the fall of potential is approximately inversely proportional to the diam. A variation of pressure causes different effects in tubes of different diameters: thus, an increase of the pressure, 2·9 mm. usually employed, raises the p.d. in tubes of 67 mm. and 41 mm. diam. and reduces it in those of 10·7 and 5·6 mm. diam. It is found that the tube of 67 mm. diam. exhibited a fall less than that corresponding to its diameter. This is put forward in support of the argument, formerly given, that the fall of potential in tubes of very great diam. ought to be nil or very small. Should this be the case, it makes easier the comprehension of the phenomena of the aurora borealis. These are simply electric discharges of enormous section which, notwithstanding their great length, are produced without the existence of such infinite p.d.'s as would have been very difficult to conceive. A. E. G.

941. *The Striation of the Positive Glow Discharge in Hydrogen.* **P. Neubert.** (Ann. d. Physik, 42. 6. pp. 1454–1503, Dec. 23, 1913. Abridged Leipzig Dissertation.)—Investigations were made on the striated discharge in hydrogen, especially with a view to the more accurate determination of the ionisation pressure in H, and experiments with other gases were also undertaken; the influence of the cross-section of the tube on the constant mentioned was also examined. Careful measurements of the p.d. between successive striæ were made by means of observations of the p.d. between two sounds inserted in the vacuum tube, combined with measurements of the length of the striæ. The chief results obtained are as follows:—(1) A substantial influence of small traces of mercury on the p.d. between the striæ was proved. A diminution of as much as 33 % may be due to this cause. (2) The striation length in mercury-free hydrogen follows the law of Goldstein, $l = c \, . \, r^{(1-m)}/p^m$, in which expression the constants $c = 1{\cdot}9$ and $m = 0{\cdot}522$ were accurately determined. (3) There occurs in hydrogen free from mercury with all pressures when there is sufficient current a constant striation p.d. of 11·9 to 12·1 volts. This is independent of the radius of the tube. (4) A new striation was observed which appeared with greater purity in the gas with cooling of the walls. In contrast to the usual blue it had a red colour with high pressures. The striæ are also much wider with high current strengths. It is first noticed at low pressures. (5) The striation-length of this decreases with falling pressure first of all from a high value, and then again increases. (6) The striation p.d. increases linearly from 12 volts at a pressure of 0·038 mm. to over 30 volts at 1 mm. pressure. When the discharge tube was cooled by liquid air similar curves were obtained. (7) Traces of oxygen, $> 0{\cdot}05\ \%$, produced the usual blue striæ. (8) The potential gradient in the positive column experienced no sudden transition at the commencement of the striation. There is a simple relation between potential gradient and pressure for the striated and unstriated discharge, viz. $G = C \cdot p^m$, which affords as a consequence with constant striation-potential-difference the Goldstein law $l = a/p^m$. (9) The author expresses the view that the striation is a disturbance of the proper continuous positive column, due to the presence of traces of electro-negative gas. J. J. S.

942. *Unidirectional Currents within a Carbon Filament Lamp.* **A. S. Eve.** (Nature, 93. pp. 32–33, March 12, 1914.)—The type of lamp used has two large loops in the filament, with the middle of the loop fixed by a short wire fused in glass. If the terminals are earthed and a charged body, either positive or negative, is brought near the lamp, then the two loops diverge like two leaves of a simple electroscope. But if the lamp is lighted and a pointed rod, connected to a Wimshurst machine, gives a powerful positive discharge, the loops are not displaced, even if the point is close to the bulb. On the other hand, with a negative discharge, even a foot or two away, the two loops of the filament rapidly and repeatedly strike the glass and spring back. The action may be explained from the fact that the lamp acts like a valve, and that the current can only pass in one direction between the hot filament and the interior of the bulb. Further experiments are described confirming this view. **F. L. Hopwood.** (Ibid. p. 84, March 26, 1914.) A. W.

943. *Ionisation in Unstriated Discharge and Arc.* **C. D. Child.** (Phil. Mag. 27. pp. 277–288, Feb., 1914.)—A discussion on the electron theory of the above phenomena. It is concluded that the amount of light given by the unstriated discharge and by the arc indicates that the rate at which ions recombine in these forms of discharge varies as the *first* power of the current instead of as the *square.* This is explained by assuming that approximately all the current is carried by electrons and not by ions of molecular size. The fact that the electric force is a linear function of the gas pressure is also explained. [See Abstract No. 1781 (1904).] E. H. B.

944. *Arc and Spark Discharge.* **A. Szarvassi.** (Phys. Zeitschr. 14. pp. 1126–1127, Nov. 15, 1913.)—Paper read before the 85. Naturforscherversamml., Wien. Ann. d. Physik, 42. 5. pp. 1031–1053, Dec. 2, 1913.)—Sketches a theory of arc and spark discharges on the basis of quasi-stationary currents. The theory is embodied in three differential equations of the first order, and this system of equations is called the "dynamical characteristic" of the discharge gap. The first equation determines the change in time of the conductivity of the gap due to self-deionisation and ionisation by the incandescent electrodes; the remaining equations give the change of temperature of the electrodes due to thermal conduction and Joulean heating. The electrode temperature is of little consequence in the case of the spark.

The equations correctly represent Simon's arc hysteresis [Abstract No. 1465 (1905)]. It also shows how a d.c. arc which is naturally unstable may be steadied by a capacity in parallel. E. E. F.

945. *Photoelectric Emission of Electrons.* **R. Pohl and P. Pringsheim.** (Phys. Zeitschr. 14. pp. 1112–1114; Discussion, pp. 1114, Nov. 15, 1913.)—Paper read before the 85. Naturforscherversamml., Wien.)—The normal photoelectric effect shows very large variations in the position of its long-wave limit. Thus, this limit is spontaneously displaced in a Ca-amalgam from 850 $\mu\mu$ to 600 $\mu\mu$. The cause of this displacement has not yet been found. The selective photo-effect is also strongly influenced by neighbouring bodies. E. E. F.

946. *Penetration, Deflection, and Interference of Refracted Electric Rays.* **G. Quincke.** (Ann. d. Physik, 43. 3. pp. 337–392, Feb. 10, 1914.)—If a hollow metallic hemisphere is set on a thin electrophorus cake and from a positively or negatively charged Leyden jar a spark is passed to the hemisphere, then from the under edge of the hemisphere—the radiator—and normal to this edge positive or negative electric rays pass out. After dusting with flowers of sulphur and vermilion, the resin surface appears coloured yellow by positive electrical rays and red by negative rays. The penetration or distance reached by the rays increases with the electric potential of the inner coating of the jar.

Conducting and insulating prisms were used in the paths of the rays, the effects being shown in many tables and diagrams, reference to the original being necessary for the details. E. H. B.

947. *Refraction, Reflection, and Interference of Electric Rays.* **G. Quincke.** (Ann. d. Physik, 43. 3. pp. 393–410, Feb. 10, 1914.)—A continuation of the work on electric dust-figures. [See preceding Abstract.] E. H. B.

948. *Loss of Energy and Ionisation produced by Kathode Rays.* **J. L. Glasson.** (Roy. Soc. Tasmania, Proc. pp. 1–4, 1913.)—The experiments of the author and of W. Wilson have shown that over a considerable range of velocities the number of ions (a) produced by a kathode ray (or β-ray) in traversing unit length of air varies inversely as the square of the velocity (v) of the ray. Thus $a = k/v^2$ and for air at atmospheric pressure $a = 1140$ and $k = 2{\cdot}5 \times 10^{23}$ [Abstract No. 60 (1912)]. Combining this result with Whiddington's absorption result $v_0^4 - v_x = ax$, where $a = 2{\cdot}0 \times 10^{40}$ [Abstract No. 558 (1912)], the author deduces that the kathode ray loses the same amount of energy per ion whatever its velocity may be, this energy corresponding to a fall through 110 volts. As the ionisation potential for air is only about 10 volts it follows that only a small fraction of the energy of the kathode or β-particle is spent in ionisation—a smaller fraction, in fact, than in α-ray ionisation. E. M.

949. *Measurements in the Electromagnetic Spectrum of Water with Slightly Damped Vibrations of 65 to 20 cm. Wave-length produced by Shock.* **A. R. Colley.** (Ann. d. Physik, 43. 2. pp. 309–318, Jan. 23, 1914.)—The author replies to Rukop's criticisms [see Abstract No. 324 (1914)] of the methods of measurement employed by him. T. H. P.

950. *Damping of Hertzian Oscillators.* **G. Leimbach.** (Phys. Zeitschr. 14. pp. 1226–1229, Dec. 1, 1913.)—Shows that it is possible to reduce the

damping in a simple or symmetrical antenna in a Marconi system by putting an auxiliary capacity in parallel with the spark-gap or within the gap, and using a quenched spark. [See also Abstracts Nos. 1486, 2001 (1913).]
E. E. F.

951. *Atmospheric Potential and Wireless Disturbances.* **G. Lutze.** (Phys. Zeitschr. 14. pp. 1148–1151 ; Discussion, p. 1151, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien. Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1100–1106, Nov. 15, 1913.)—The author used a new water-drop collector with combined pressure and suction spraying, and this, with a Wulf string electrometer, determined the atmospheric potential within 8 secs. By means of this instrument, very rapid changes in the atmospheric potential could be discovered. It was found that these changes are particularly rapid when the gradient itself is low. Moreover, they are often oscillatory and exhibit a high frequency. When that is the case, they give rise to "strays" in wireless receivers. Balloon trips made with this apparatus showed a great prevalence of these rapid changes inside clouds, especially the upper and lower cloud surfaces; but they gradually decrease as the height increases. E. E. F.

952. *Propagation of Waves in Wireless Telegraphy.* **G. Lutze.** (Phys. Zeitschr. 14. pp. 1151–1153, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien. Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1107–1110, Nov. 15, 1913.)—Wireless signals from Norddeich and special signals from the Eiffel Tower were observed in free balloons at heights up to 6100 m. It was found that the Paris signals fell to one-eighth of their loudness in ascending from 1050 to 5500 m., Paris being 9° below the horizon at the latter height. The Norddeich signals fell to about half their intensity. The loudness was determined by the shunted telephone method. The experiments prove the existence of Sommerfeld's surface waves. The space waves are in the case of Paris intercepted by the horizon; hence the large decrease. Measurements of the influence of the distance between the stations upon the loudness show a decrement intermediate between the value for wet and the value for dry ground. The balloons used ascended from Bitterfeld. E. E. F.

953. *Coupled Receiver in Wireless Telegraphy.* **H. Riegger.** (Jahrbuch d. Drahtlosen Telegraphie, 8. pp. 58–79, Jan., 1914.)—The paper is purely theoretical. It deals particularly with sharpness of resonance as regards current-effect in a coupled receiver. The incident wave is assumed to be of one frequency only. The decrements of the three waves may have any suitable values. The coupling is assumed to be extremely loose.
T. P. B.

954. *General Law of Magnetic Coupling.* **F. Kiebitz.** (Jahrbuch d. Drahtlosen Telegraphie, 8. pp. 45–57, Jan., 1914.)—The paper is purely mathematical. It gives an approximate solution of the cubic equation required to be solved for two magnetically coupled wireless telegraphy oscillation circuits. With an accuracy of $0{\cdot}25\delta^2$ % the approximate law of magnetic coupling is deduced, which gives the frequencies, amplitudes, phases, and damping-factors; δ being of the order of magnitude of the log. decrement of a circuit when not coupled. The paper also gives a new method of calculating the current-integral in the secondary circuit. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

955. *Absolute Measurements of Resistance.* **F. E. Smith.** (Roy. Soc., Phil. Trans. 214. pp. 27–108, March 19, 1914.)—The method adopted is one based on that of Lorenz. The instrument has 2 rotating discs and 4 magnetising coils instead of 1 disc and 1 coil as in the usual form of Lorenz apparatus. The magnetising coils are wound in single layers on marble cylinders, and the disposition of the coils with respect to the discs is such that the resulting magnetic fields through the discs are opposed in direction and the intensity of the field at points in the neighbourhood of the edge of a disc is of zero value, or nearly so. Each of the two discs supports 10 insulated phosphor-bronze segments placed at equal distances around its circumference, and the 10 segments on one disc are connected to those on the other disc by 10 conducting wires passing through the centre of the shaft. When the wires rotate with the discs a difference of potential is produced between their ends. The 10 conductors are treated as 5 sets of two, and the 5 sets are at times placed in series by means of 10 brushes (5 to each disc), and at other times they are placed in parallel. The difference of potential produced by rotation is balanced against that on a standard resistance R through which the same current flows as through the coils. The resistance R is thus found in terms of the rate of rotation of the conductors and the mutual inductance of the coils and brush contact circles. The resistances measured had nominal values of 0·001 ohm, 0·002 ohm, and 0·01 ohm. The observed values in absolute measure and the values in International ohms, are given in the following table :—

No. of Observations		Resistance.			Difference, parts in 100,000 (Abs. × 10—9) – (Int.).
		Standard.	Absolute Measure, cm./sec.	In International Ohms.	
28		0·001 ohm	100091_6	0·00100039$_3$	52_3
12		0·01 ,,	100090_{10}	0·0100088$_3$	51_8
5		0·002 ,,	Standard resistance varied		53_0
2	Coils 1 and 2 used	0·001 ,,	100090_4	0·00100039$_3$	51_1
2	Coils 3 and 4 used	0·001 ,,	100091_8	0·00100039$_3$	52_5

The conclusion is that a resistance of 1 International ohm is equal to 1·00052 ± 0·00004 ohm (10^9 cm./sec.$^{-1}$), the probable error of ± 0·00004 being the sum of those involved in the realisation of the ohm and the International ohm. It follows that a column of mercury at 0° C., 106·245 ± 0·004 cm. long, of constant cross-sectional area (the same as that of the International ohm), has a resistance of 1 ohm. The mass of this column will be 14·4446 ± 0·0006 gm

F. E. S.

956. *Thermo-electromotive-force.* **C. Dannecker.** (Ann. d. Physik, 42. 6. pp. 1504–1530, Dec. 23, 1913.)—The occurrence of a double neutral point in the e.m.f. of certain thermo-elements has been investigated by the author between the limits of temperature — 200° and + 1000° C. The method of comparison of e.m.f.'s used was a compensation one similar to that employed by Chassigny, Abraham and Noll, a moving-coil galvanometer being used as

a null instrument. The occurrence of a double neutral point was shown in the case of the following junctions: Co-Ni, cobalt-German silver and cobalt-nickelin. The approximate course of the curves connecting e.m.f. and temperature was determined in the case of the thermo-elements: Nickel-German silver, cobalt-nickel iron, nickel-nickel iron, constantan-nickel, nickel-nickelin, constantan-cobalt, aluminium bronze-iron, and cobalt-iron, between the temperatures − 200° and 1000°. These are given in tables and diagrams. Confirmation was obtained of the remarkable course of the e.m.f. curve of iron-nickel iron as described by Barrett, of nickel-iron (Harrison) and of copper-cobalt (Pécheux). A division was made of the curves obtained into definite groups which the connection between the e.m.f. and the materials of the thermo-elements easily allows to be perceived. J. J. S.

957. *Peltier-effect at High Temperatures.* **P. Cermak.** (Phys. Zeitschr. 14. pp. 1178–1179, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien. Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1163–1164, Nov. 15, 1913.)—The Peltier-effect is made visible by means of an iron wire and a constantan wire soldered end to end with gold, so as to make apparently a single wire. This is suspended in a glass vacuum tube, and a block of Cu is attached to the lower end, where it dips into mercury to make a contact. On sending a current of some 5 amps. through the wire, the junction either glows more brightly than the rest or remains dark, according to the direction of the current. The effect may also be shown by welding a Pt-wire 0·3 mm. thick to a 40 % Pt-Rh wire, and it may then be shown by projection, although not so distinct as in the iron-constantan combination. A somewhat similar effect may be seen in the thickened end of a Nernst filament. E. E. F.

958. *Electrification at Liquid-gas Surfaces.* **H. A. McTaggart.** (Phil. Mag. 27. pp. 297–314, Feb., 1914.)—A rotating cell method of examining the electric charges on small spheres of gas in a liquid has been devised. Confirmation is obtained of Quincke's observation that in distilled water through which an electric current is passing, small bubbles of air, oxygen or hydrogen move towards the positive pole (Pogg. Ann., 113. p. 513, 1861). The velocity of small gas spheres in water is found to be proportional to the potential gradient and, within limits, independent of their size. For bubbles of air, oxygen and hydrogen in water, the velocity is found to be about 4×10^{-4} cm. per sec. per volt per cm. Dissolved salts affect the charge at a gas-liquid surface, the activity of the salt depending on the charge carried by its ions in solution. In absence of polyvalent ions, an air-water surface is electrically neutral in a slightly acid solution. A sphere of gas in a solution can change the sign of its charge as it diminishes in size owing to its absorption into the solution. Under the conditions of the author's experiments, the electric charge at a liquid-gas surface appears to be almost independent of the nature of the gas. T. H. P.

959. *Measurement of Electric Potentials at a Distance without Wires.* **B. Szilard.** (Comptes Rendus, 158. pp. 561–564, Feb. 23, 1914.)—In strongly ionising the air between an electrically charged body and an insulated conductor at the potential of the earth, a passage of charge takes place and the lines of force undergo a modification. It follows that the insulated conductor is raised to a real potential, higher than that corresponding to the value of the

field, at that distance, in air which is not ionised. A disc furnished with a strongly radio-active substance serves at the same time as ionising source and means of estimating the potential. This arrangement, placed upon an insulated support, is connected to a direct-reading electrometer which indicates the voltage. A list of experiments which can be tried with the apparatus sketched is given. The method described can be applied to the measurement of high electric pressures from a distance without any contact with the conductor. It is also of use for measuring the electrification of insulators and rotating bodies with which it is not possible to establish electric contact. A. E. G.

960. *Electric Double Layers on Metals in a Vacuum.* **R. Seeliger.** (Phys. Zeitschr. 14. pp. 1287–1288; Discussion, p. 1288, Dec. 1, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—In measurements of the specific charge of electrons, etc., many errors are introduced by the formation of electric double layers on electrodes and neighbouring metallic surfaces. These can be entirely eliminated by kathode sputtering from the material to be cleaned. The sputtering should be repeated before each important measurement, as the immunity lasts only a few minutes. Platinum is preferable. E. E. F.

961. *Electric Conduction in Metals.* **F. Skaupy.** (Deutsch. Phys. Gesell., Verh. 16. 3. pp. 156–167, Feb. 15, 1914.)—Discusses under certain assumptions the electric conduction in liquid mercury; liquid amalgams; diffusion phenomena; dissociation of liquid mercury; also the case of solid metals. [See Abstract No. 1398 (1907).] E. H. B.

962. *Inaccuracy of a Copper Voltameter.* **N. Dhar.** (Zeitschr. Elektrochem. 19. pp. 746–748, Oct. 1, 1913.)—Like Richards and others the author finds by coupling a copper voltameter in series with a silver voltameter, that the copper voltameter is not reliable for weak currents (0·5 to 5 milliamps.), and that the various researches by different workers do not explain why the results are generally far too low. H. B.

963. *Radium Measurements by the γ-Ray Method.* **V. F. Hess.** Deutsch. Phys. Gesell., Verh. 15. 20. pp. 1002–1016, Oct. 30, 1913. Paper read before the 85. Naturforscherversamml., Wien. Phys. Zeitschr. 14. pp. 1135–1141, Nov. 15, 1913.)—Wulf's double-fibre string electrometer may be used for the measurement of the strength of Ra or mesothorium preparations by means of the ionisation produced within the electrometer case by the γ-rays of the preparation when placed at a certain distance (say, 1 m. for 30 mgm. metallic Ra) from the preparation. When the capacity and sensitiveness of the electrometer are accurately known, the Ra measurement may be made an absolute one with the knowledge of the ionising power of γ-rays and the amount of γ-rays emitted by a given quantity of Ra. The absolute measurement thus made is liable to errors of 2 or 3 per cent. Comparisons with standard preparations may be made to within ½ per cent. The sensitiveness preferred is 4 volts per division. The wall of the case consists of brass 3 mm. thick. The author also describes a method not involving a time measurement. It employs a single-fibre electrometer, with the ionisation chamber earthed through a xylol resistance and connected to the fibre. The deflection of the fibre is accurately proportioned to the ionisation. E. E. F.

964. *Apparatus for Radio-active Measurement.* **B. Szilard.** (Archives d'Él. Médicale, 22. pp. 28–33, Jan. 10, 1914.)—A rigid needle provided with a spiral spring moves over a fixed scale, being attracted by a charged sector. The rate of movement over the scale measures the loss of charge and by connecting up to suitable ionisation chambers any kind of radio-active measurement can be made by direct observations without telescope, etc. Activities of the order of 1/100 the α-ray activity of uranium oxide can be measured. E. M.

965. *Theory of the String Galvanometer.* **R. Förster.** (Elektrotechn. Zeitschr. 35. pp. 146–149, Feb. 5, 1914.)—A mathematical paper on the string galvanometer, in which the author obtains from the equations of motion of the string, the forms of motion of the string with and without air damping, and the connection between the sensitiveness and the frequency when a sinusoidal current is passed through the string. The results so obtained are compared with experimental data. For further particulars the original should be consulted. W. C. S. P.

966. *Sensitive Photoelectric Cell.* **A. L. Hughes.** (Phil. Mag. 25. pp. 679–682, 1913.)—Constructional details of a sensitive cell for which very great sensitiveness is claimed are given. Only a very small amount of metal (K, Na, Rb, Cs) is required. In the case of the last two this is of some importance owing to their expensiveness. L. H. W.

967. *Continuous-current Galvanometer instead of Telephone as Zero Instrument in Alternating-current Measurements.* **G. Pfleiderer.** (Zeitschr. Elektrochem. 19. pp. 925–931, Dec. 1, 1913.)—The author takes alternating-current measurements by means of a continuous-current galvanometer, used as zero instrument, by inserting in the zero-lead of the bridge an auxiliary interrupter which oscillates in synchronism with the automatic interrupter of the induction apparatus and is of similar construction (band spring). This insertion introduces a certain asymmetry into the bridge; but the theoretical and experimental investigations show that the average error is about the same for the new method and the telephone method, even when the polarisation causes an error of nearly 1 per cent. The disadvantage of the new method is that asymmetries and errors are less readily noticed than with the telephone; the advantages are the absence of noise, greater convenience, and decidedly greater sensibility, and the possibility of making use of precision rheostats. H. B

968. *Electrical Foam Walls.* **G. Quincke.** (Ann. d. Physik, 43. 3. pp. 411–460, Feb. 10, 1913.)—A discussion of the electrical nature of the partitions of the foam or froth cells in oily or soapy compounds. E. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

969. *Apparatus for the General Cryomagnetic Investigation of Substances of Small Permeability.* **H. K. Onnes** and **A. Perrier.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 689–699, Jan. 29, and pp. 786–789, Feb. 26, 1914. Communication No. 139a from the Phys. Lab., Leiden.)—The construction of the apparatus described forms part of a more general scheme gradually to obtain the necessary appliances for the investigation of weak magnetisation at low temperature [see also Abstract No. 168 (1914)]. It is suitable for cylindrical specimens and may, without important change, be

adapted to the study of small objects placed at the point of maximum attraction; it can also be used for liquids. The magnetic attraction or repulsion on the specimen is caused to act along the vertical, and is measured by compensating it by means of the electromagnetic attraction of two coaxial coils. The specimen is attached to a carrier which can move vertically in an air-tight enclosure between the poles of the electromagnet which supplies the applied force. The weight of the carrier is balanced by two floats immersed in mercury. Details of the working of the apparatus are then given, a relative accuracy of about ¼ per cent. being obtained in susceptibility measurements.

G. E. A.

970. *Extension of Thomson's Theory for the Constitution of Magnets by Vaschy's Method.* **J. B. Pomey.** (Journ. de Physique, 4. Ser. 5. pp. 126–134, Feb., 1914.)—According to Thomson's theory, each volume element $d\bar{w}$ of a magnet is supposed to be an elementary magnet of moment $\mathrm{I}d\bar{w}$ made up of two equal masses of contrary sign of an imaginary fluid obeying Coulomb's law. The potential V is then equal to $-\int\left(\mathrm{I}, \operatorname{grad}\frac{1}{r}\right)d\bar{w}$, the integral being extended throughout the volume V of the magnet. The bracket represents the scalar product: $-\mathrm{A}\partial\frac{1}{r}/\partial x-\mathrm{B}\partial\frac{1}{r}/\partial y-\mathrm{C}\partial\frac{1}{r}/\partial z$ where A, B, and C are components of I. From this is deduced the expression $\mathrm{V}=-\int\frac{div\,\mathrm{I}}{r}\,d\bar{w}-\int\frac{(\mathrm{I}v_i)}{r}\,ds$, the surface integral being taken over the surface of the magnet. $\mathrm{I}v_i$ represents the scalar product of I by the unit vector V_i normal to $d\mathrm{S}$ and directed towards the interior of the magnet. The object of the present note is to establish this second potential formula by mathematical reasoning based on Coulomb's experiments and on the behaviour of a broken magnet without recourse either to an imaginary fluid or to action at a distance.

H. H. Ho.

971. *Effects related to the Hall-effect.* **E. P. Adams.** (Phil. Mag. 27. pp. 244–252, Feb., 1914.)—Investigates the Corbino effects on the electron theory and discusses their relation to or identity with the Hall-effect. [See Abstract No. 1597 (1911).]

E. H. B.

972. *The Diurnal Variation of Terrestrial Magnetism.* **G. W. Walker.** (Roy. Soc., Proc. Ser. A. 89. pp. 379–392, Jan. 1, 1914.)—Schuster has made a most inspiring and systematic attempt to reduce the observational matter obtained at various observations to scientific law and order. In departing from the method pursued by him, this change of procedure was in no small degree suggested by various remarks in Schuster's memoirs. When the instruments at Eskdalemuir Observatory were so arranged as to record directly the geographical components of magnetic force, and the tabulated results for 1911 took definite shape the results were compared by the author with those of the only other observatory which at the time also recorded those components, namely Potsdam (Seddin). The comparison brought out points of interest and induced the author to collect data from other observatories as to the deduced values for the geographical components.

Following Schuster, the desired data were the Fourier coefficients in the geographical components. Investigation was confined to the 24-hour and the 12-hour terms, for it is realised that the errors which arise on the experimental and observational side, render the shorter-period terms of very doubtful accuracy. Attention was further confined to the average yearly value, not because the seasonal variation is unimportant but to avoid error in dealing with a multitude of facts. The data obtained from Pavlovsk, Eskdalemuir, Wilhelmshaver, Potsdam, De Bilt, Pola, Helwan, Bombay, and Batavia are given in tabular form. It is stated that: (1) Practically all days are used, not selected quiet days. (2) The original curves are not smoothed, except in the case of the V results for Pola. (3) The original curves gave records of H and D except at Eskdalemuir and Seddin, where N and W were directly recorded. (4) The hourly values are those at the exact hour, except at Seddin, where the hourly value is the estimated mean for an hour centring at the exact hour. It is desirable that data should be obtained precisely in the same way, and before entering on a minute arithmetical computation, all data should refer to the same year. But it became obvious to the author that it would be necessary to wait several years before such data could be obtained. Still broad inferences may be drawn from the data collected in the table which seem of vital importance. If, according to Schuster, it is correct to represent the variations by a potential function the problem may be divided into two parts:—(1) The empirical determination of the potential function which represents the observations. (2) The theoretical investigation of the physical causes that give the potential function so determined. For the computations entered upon by the author reference should be made to the original paper. He remarks that a simple specification has been formed of the terms which seem to fit with the data. He has no theory to propose as to their origin, beyond Schuster's view that they arise from differential conductivity of the upper regions of the atmosphere. If further data confirm the probable reality of the terms, it should not be a difficult matter to express the law of conductivity which would account for them. As we have only had to proceed to second differentials with regard to the sun's direction, or the earth's way; it does not look as if the differential conductivity required is of a very complex nature.

The possibility of associating the electric and magnetic state of the earth with its translational movement has often attracted attention although without success. There follows a general solution of the electro-magnetic equations for a body of conductivity C moving in a straight line with velocity KC, where C is the velocity of radiation. E. O. W.

973. *Propagation Velocity of Magnetic Disturbances and Pulsations. Report on Records of Terrestrial Magnetic Disturbances made at Apia (Samoa), Batavia, Cheltenham, and Tsingtau for September,* 1911. **G. Angenheister.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 4. pp. 565–581, 1913.)—The object of the present paper was to obtain data for the study of magnetic disturbances and pulsations, by means of a system of rapid registration which allowed movements recorded at distant stations to be identified with certainty. Previously van Bemmelen, from a comparison of similar observations, came to the conclusion that the registered pulsations were not simultaneous, although the differences are only very slight. Also K. Birkeland of the Norwegian Aurora Polaris Expedition, 1902–3, opined that the difference between the incident times at the various observatories was too small to be detected by the mode of registration adopted. From a comparison of 88 disturbances between the years 1883–1908, L. A. Bauer arrived at an opposite result to Birkeland, finding the disturbance to be propagated with a measurable velocity round the earth, the average time for a complete revolution either eastwards or westwards being about 7 minutes. In Dec., 1910, the Depart-

ment of Terrestrial Magnetism of the Carnegie Institution requested every observatory to furnish particulars on the incident phases of the 15 most remarkable disturbances between the years 1906–1909. From the response made by 32 observatories the present paper dealing with the propagation velocity owes its existence. The author groups the 32 stations according to their geographical longitude into 4 divisions, and gives tables of data arranged according to this classification. He has also submitted the 17 cases of Bauer to the same exact analysis as the present series, numerous curves and tables being given. As a general conclusion, the author states it to be highly probable that the time-differences between separate groups do not constitute a measure for the determination of disturbance velocities but rather of observation errors. It is open to doubt whether it will be possible to determine velocity propagation from disturbance incidence, since this depends not only on the efficiency of registration but also upon the certainty of identifying definite phases at different stations. The author also believes he has established that the time-difference between pulsations at different observatories is smaller than that given by the records—a fact of great importance for the physical significance of these magnetic phenomena. Since for large distances the pulsations succeed practically simultaneously, the author believes them capable of utilisation for the determination of geographical longitude.

H. H. Ho.

RADIOLOGY AND ELECTROPHYSIOLOGY.

974. *Elimination of Secondary Radiations produced in a Radiographed Object.* **G. Bucky.** (Archives d'Él. Médicale, 22. pp. 92–95, Jan. 25, 1914.)—Röntgen rays produce two kinds of secondary rays: one which arises in the walls of the tube, the other in the object radiographed. The quality of a radiograph depends, in the first place, on the absence of these secondary rays. A screen is described and photographs are given showing the effect the screen has on preventing the secondary radiation from acting upon the radiograph. It is believed that this screen will be particularly useful when radiographs of soft parts are required. The image of the screen appears on the plate as a system of squares. While this may not be without advantage in certain cases in which it is desired to measure some organ, yet, in other instances, it would be somewhat of a hindrance. Further experiments are in progress to see if the image of the screen can be eliminated. A. E. G.

975. *Correct Optical Valuation of Modifications of the Colour of Radiodosemeters.* **G. Bucky.** (Archives d'Él. Médicale, 22. pp. 139–143, Feb. 10, 1914.)—Many radio-dosemeters utilise the modification of the colour of certain chemical substances, when subjected to the action of Röntgen rays, as a measure of the dose of the applied rays. For that purpose pastilles of different colours, the shade of which is determined empirically, are compared with a pastille on which the radiation has acted. There is thus always the great difficulty of judging which colours nearest approach each other in shade. Further, the luminous source available when making the comparison plays an important part in the estimation. It is claimed that the method now described removes these difficulties and has the following advantages:—The dose can be read with optical exactness, by means of a constant luminous source, other causes of optical errors being also removed. It facilitates the estimation by transforming a comparison of colours into a comparison of brightness. The estimation can be made during the time the radiation is in

action, there being no need to remove the pastille from the tube. The fractional doses can be determined with an exactitude of 1 to 2r. The diminution of tint is avoided, since the pastille is completely protected from daylight during the action of the radiation and also during the comparison.

A. E. G.

976. *Comparison of Scales of Hardness and Quantitometers.* (Archives d'Él. Médicale, 22. pp. lx., Feb. 10, 1914.)—The following tables indicate the concordance of the principal notations.

I.—Scales of Hardness of Rays.

Benoist.	Benoist-Walter.	Wehnelt.	Walter.
Degrees B.	Degrees B—W.	Degrees Wh.	Degrees W.
2	1	About 1·8 to 2	2 to 3
3	2 to 3	5	4 to 5
4	4	6½	5 to 6
5	4½	7¼	6
6	5	8	6 to 7
7	5½	9	7
8	6	10 to 11	7 to 8

II.—Quantitometers and Quantitometric Units.

Chromo-radiometer Holznecht.	Radiometer Sabouraud-Noiré.	Chromo-radiometer Bordier.	Units. Bordier Galimard.	Fluorimetric Quantitometer Guilleminot.	Quantitometer Kienböck.	Fällungs-radiometer. Schwartz.
Units H.,	Tints.	Tints.	Units I.	Units M.	Units X.	Kaloms.
1 H				**125 M**	**2 X**	
1½ H				187 M	3 X	**1 Kalom**
3 H		Tint O	1·8 I	375 M	6 X	2 Kaloms
4 H		Tint O to I	2 to 3 I	500 M	8 X	
5 H	**Tint B**	**Tint I**	**3 to 4 I**	625 M	**10 X**	3·5 Kaloms
6 H		Tint I to II	4 to 5 I	750 M	12 X	
7 to 8 H		Tint II	5 to 6 I	865 to 1000 M	14 to 16 X	
14 H		Tint III	10 I	1750 M	28 X	
20 to 22 H		Tint IV	15 I	2600 M about	40 to 44 X	

The items in heavy type show the connections between the scales.

A. E. G.

977. *"Villard" Vacuum Tubes.* (Brit. Pat. 29,839 of 1912. Elect. Engineering, 10. p. 69, Jan. 29, 1914. Abstract.)—In the arrangement due to E. W. Caldwell the kathode is arranged to cause sufficient concentration of the kathode stream under abnormal regulating conditions to introduce or generate gas in the tube and to restore it automatically to its normal condition. A large surface kathode, a small focusing member, and a loosely movable spherical mirror concentrate the heat of the kathode to effect the regulation. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

978. *Modified Hittorf Model for Demonstrating the Migration of the Ions.* **F. Weigert.** (Zeitschr. Electrochem. 19. pp. 886–887, Nov. 15, 1913.)—The model illustrates in particular the electrolysis of cupri- and cupro-salts, with soluble and insoluble electrodes, with the aid of sliding metal plates and coloured glasses (white, blue, green, red). H. B.

979. *Active Nitrogen.* **E. Tiede** and **E. Domcke.** (Ber. Deutsch. Chem. Gesell. 46. 17. pp. 4095–4103, Dec. 29, 1913, and 47. 2. pp. 420–426, Feb. 7, 1914.)—The authors adhere to their statement that certain phenomena, which had been ascribed to active nitrogen, are not observed when pure nitrogen is used, but make their appearance when oxygen is introduced. Active oxygen alone is capable of producing some of these phenomena. They fail to confirm Strutt as to experiments with iodine, sulphur, sodium, and thallium chloride. The afterglow of the nitrogen becomes weaker and finally disappears as the nitrogen is more and more purified of oxygen by being passed ever heated copper; care must, however, be taken not to heat the copper above the dissociation point of copper oxide, otherwise the glow will appear. **F. Fischer** (Ibid. 46. 17. p. 4103, Dec. 29, 1913) agrees with Tiede and Domcke. **H. B. Baker** and **R. J. Strutt.** (Nature, 92. p. 659, Feb. 12, 1914.)—Repeating Tiede and Domcke's experiments with barium or potassium azide, the authors do observe the questioned afterglow. They also find it when the discharge bulb is filled with the liquid alloy of potassium and sodium and with rarefied nitrogen; the surface of this alloy was still bright after several weeks, and the afterglow as distinct as before. They ask, moreover, which gas—if not active nitrogen—could effect the reduction of hydrocarbons to hydrocyanic acid observed by Strutt. **A. Koenig** and **E. Elöd.** (Ber. Deut. Chem. Gesell. 46. 13. pp. 2998–3009 1913, and 47. 3. pp. 523–530, Feb. 21, 1914.)—The authors criticise Fischer and Hene and confirm Strutt and Baker. If Tiede and Domcke had analysed their gases spectroscopically they would have noticed that the gases contain mercury-vapour; this vapour destroys the afterglow because the mercury at once combines with the active nitrogen to nitride, momentarily showing the greenish mercury luminescence, as the authors together with E. Szöllösi observed (research not yet published). **H. B. Baker** and **R. J. Strutt.** (Nature, 93. p. 5. March 5, 1914.)—Again repeating the new experiments of Tiede and Domcke with regard to the elimination of any trace of oxygen by heating finest gauze of copper slowly from 15° up to 430° C., the authors do not observe any distinct change in the intensity of the afterglow. The statement by Tiede and Domcke, that active oxygen could alone produce the characteristic effects of active nitrogen, altogether fails to account for the formation of hydrocyanic acid which Tiede and Domcke do not dispute.

H. B.

980. *Decomposition of Highly-complex Chemical Compounds in Varying Magnetic Fields.* **G. W. Heimrod.** (Zeitschr. Elektrochem. 19. pp. 812–816, Oct. 15, 1913.)—Experiments made in Hanover on behalf of the Rockefeller Institute for Medical Research of New York do not confirm the communication addressed to the Berlin Academy by I. Rosenthal [Abstract No. 689

(1908)], which R. Cegielskij had already questioned. Solution of starch, 2·5 per cent., was placed within a solenoid through which alternating currents of about 450 (200 to 900) cycles per sec., produced with the aid of a Wehnelt interrupter, were sent for several days, the temperature of the solution being raised up to 90° C.; a water-jacket was interposed as the coil became very hot. A very slight inversion was sometimes observed; but it was practically the same within and without the magnetic field, also in the presence of an electrolyte, NaCl, HCl, H_3PO_4, and of diastase. H. B.

981. *Curious Atomic Weight Relations.* **F. H. Loring.** (Chem. News, 108. p. 247, Nov. 21, 1913.)—The author regards the discovery of gallium in commercial Al by Boulanger and Bardet (Comptes Rendus, 157. p. 718, 1913) as related to Thomson's observation of a very faint line, corresponding with an atomic weight of about 35, on the plate showing the strongest He line [Abstract No. 1862 (1913)]. If gallium is widely distributed in nature its presence in a vacuum tube is not strange, and as this metal has physical properties closely resembling those of mercury, it might carry a double charge and consequently have an atomic weight of half 70. Gallium does not fall into line with the other elements in the author's scheme [see Abstract No. 1112 (1909)], and, from the tabular arrangement given, it should apparently fall on the curve with bromine. This would entail a value of 71·37, which would find a place in the extension of the author's scheme [see Abstract No. 294 (1910)], and this value (taken as 71·33), together with the fact that the element is related to thallium, renders possible the series:

	Differences.		
H 1·01			
	7·89		
Be 8·90		18·66 (*b*)	$2a = b$ and $a + b = 28$.
	26·55		
Cl 35·45		9·33 (*a*)	
	35·88		
Ga 71·33			

T. H. P.

982. *Valency of Radio-active Elements.* **G. v. Hevesy.** (Phys. Zeitschr. 14. pp. 1202–1209, Dec. 1, 1913.)—The valencies of fifteen radio-active bodies were determined by means of their diffusion in acid solutions. The valencies thus formed agree without exception with those derived from the general chemical character of the elements. Actinium gives trivalent ions, which supports the view that it is the missing homologue of lanthanum. In alkaline solutions the disintegration products of the emanations are present in a colloidal state, as supposed by Paneth and Godlewski. Polonium is colloidal in neutral and feebly acid solutions. The colloid particles contain sometimes only two or three atoms. E. E. F.

983. *Theory of Polymorphism.* **G. Tammann.** (Phys. Zeitschr. 14. pp. 1087–1098; Discussion, p. 1098, Nov. 15, 1913. Paper read before the 85. Naturforscherversamml., Wien.)—Assumes that molecules in the process of crystallisation become anisotropic and take up the relative positions demanded by this structure. Certain molecules can be anisotropic in various directions, and this gives rise to polymorphism. This view is illustrated by the crystallisation of water. E. E. F.

984. *Structure of Diamond.* **L. Föppl.** (Phys. Zeitschr. 15. pp. 191–193, Feb. 15, 1914.)—Discusses the fundamental form on which the structure of the diamond is based. [See also Abstract No. 1778 (1913).] A. W.

985. *Preliminary Report on Uranium, Radium, and Vanadium.* **R. B. Moore** and **K. L. Kithil.** (Bureau of Mines, Bull. 70. [97 pp.] 1913.)—The bulletin presents a summary of available information regarding the sources of uranium, radium and vanadium, the methods used in treating the ores, and the uses of the finished products. In particular the paper describes the ores found in the United States, giving especial attention to those characteristics of the ore and the conditions of their occurrence that affect mining and treatment. E. M.

986. *The Allotropy of Copper.* **E. Cohen** and **W. D. Helderman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 628–632, Jan. 29, 1914.)—Electrolytic copper has been cast into ingots and quenched in water immediately after solidification. Determinations of the density of turnings indicated an increase from 8·89 to 8·90 after heating for 24 hours at 100° C. Subsequent dilatometric experiments showed that copper undergoes an allotropic change at 71·7° C. In solid metal the change is remarkably slow but the rate can be accelerated by the use of fine turnings or by boiling in a solution of an electrolyte such as copper sulphate solution. F. C. A. H. L.

987. *The Metastability of Metals in Consequence of Allotropy and Its Significance for Chemistry, Physics and Technics.* **E. Cohen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 632–634, Jan. 29, 1914.)—The author points out that, in view of the latest work on the allotropy of metals formerly thought to be capable of existence in only one form [see preceding Abstract], it will be desirable to redetermine the various physical constants in the stable systems, since the existing values have been determined in metastable systems containing unknown proportions of the α and β modifications.
F. C. A. H. L.

988. *Ascending and Descending Cold Work.* **Hanriot** and **Lahure.** (Comptes Rendus, 158. pp. 404–406, Feb. 9, 1914.)—Cold work and annealing affect the various mechanical properties of metals in such a manner that one is justified in asking if the two are interdependent. A metal can be mechanically hardened to a predetermined degree (as measured by ball hardness) either by direct cold work or by subjecting the metal to the max. amount of cold work it will stand followed by suitable annealing. The first process is described as "ascending cold work" and the second process as "descending cold work." Tensile tests carried out on silver and brass cold-worked by both processes show that for equal degrees of hardness the tensile strengths of the "ascending" specimens are less, and the elongations greater, than the corresponding properties of the descending specimens. It has also been shown that subsequent cold work to rupture invariably produces a greater degree of hardness in the descending samples. Annealing at constant temperature produces, in the early stages, a more rapid fall of the hardness of the specimens cold-worked by the descending method than in those treated by the ascending process. Ultimately, however, a limiting value is reached which is the same for both varieties. In every case the variations in the partially annealed samples are more regular than those observed in the directly hardened samples. F. C. A. H. L.

989. *Minimum Temperature of Annealing.* **Hanriot** and **Lahure.** (Comptes Rendus, 158. pp. 262–264, Jan. 26, 1914.)—Experiments have been made to determine the lowest temperature at which annealing of plates of silver (cold-hardened to different extents) takes place, by noting their ball

hardness numbers after 4 hours' heating at the particular temperature. The results show that the annealing temperature decreases as the degree of cold working increases. In severely strained material annealing is very rapid after it has once set in, so that the hardness soon falls below that of a plate less severely worked. Experiments carried out on silver and zinc over prolonged periods of time showed that annealing is slow at low temperatures. A plate of zinc showed no effect after 8 hours at 78° C. but a considerable decrease had occurred after 18 hours. More prolonged heating (15 hours) did not affect the results. F. C. A. H. L.

990. *Weldability of Metals and Alloys.* **R. Amedeo.** (Rev. de Soudure Autogène IV. p. 462, 1912. Rev. de Métallurgie, 11. pp. 57–58, Jan., 1914. Extract.)—The welding power of alloys is intimately bound up with the phenomena which immediately precede and accompany fusion, and an examination of the liquidus and solidus of alloys enables limits to be fixed between which such materials will weld readily. For this purpose the temperature-difference between liquidus and solidus should not be great, as this permits of penetration of oxygen and resultant burning of the metal. In the iron-carbon series alloys containing up to 0·5 % carbon can be welded readily; between 0·55 and 0·8 % carbon welding can be effected with difficulty and with considerable danger of burning, while the alloys containing about 2 % carbon present the greatest difficulty in welding. Alloys with 4 % carbon can be welded readily. In every case it is necessary to anneal after welding and in the case of the 0·65 to 0·8 % alloys it is advisable to quench first and then anneal. In brasses, alloys in the neighbourhood of 65 % Cu and 35 % Zn show the greatest welding power. F. C. A. H. L.

991. *Recrystallisation of Cold-worked Zinc.* **G. Timofeeff.** (Rev. de Métallurgie, 11. pp. 127–132, Jan., 1914.)—A study has been made of the relationship existing between the microstructure of zinc and the mechanical and thermal treatments to which it has been subjected. The best etching agent for Zn has been found to be a few drops of a solution containing 94 % strong nitric acid and 6 % chromic acid in 100 c.cm. of water. Cast metal shows grains variously coloured according to their crystalline orientation and varying in size according to the size of the mould in which the metal was cast. Cold-working was effected by crushing in a vice; feeble work crushed the grains, but under heavy pressure the edges of the grains became indistinguishable, and even under high magnifications it was impossible to detect anything but striæ in the direction of elongation. Subsequent annealing experiments showed that after a fortnight there were signs of spontaneous recrystallisation at the ordinary temperatures. The rate of growth, and ultimate grain-size obtained increased with the temperature of annealing. At the same time the increase in hardness brought about by crushing, diminished until it attained the value of that of the cast metal. The rate of recrystallisation is also increased by the degree of deformation. Under slight shock the crystals which have been caused to grow become crossed with striæ. Similar structures are sometimes observed in cast samples and are caused by shock in removing the metal from the mould. F. C. A. H. L.

992. *The Allotropy of Zinc.* **E. Cohen** and **W. D. Helderman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 565–568, Dec. 27, 1913.) —Since the results of many workers point to the existence of a transition-point in zinc in the neighbourhood of 350° C. it might be expected that

ordinary Zn forms a metastable system containing two or more allotropic modifications of the metal. This view is strengthened by the considerable variations found in the figures published for the density of Zn. Chemically-pure Zn was melted and cast in an asbestos-paper mould cooled in a mixture of solid CO_2 and alcohol. The resulting ingot had a density of 7·180. After heating to 100° C. in a solution of zinc sulphate (saturated at 15° C.) for 886 hours the density had fallen to 7·102. The authors consider that these experiments prove that "zinc" must be considered as a metastable system and that the variety found at high temperatures changes only very slowly into the modification stable at low temperatures. Since the difference in the specific volume of the two varieties is great, all objects made from zinc will disintegrate in the long run. This throws considerable doubt on the stability of deposits produced by the Schoop process—a subject upon which it is hoped to report shortly. F. C. A. H. L.

993. *Hardness and Conductivity of Zinc-Cadmium Alloys.* **A. Glasunow.** and **M. Matweew.** (Int. Zeitschr. Metallog. 5. pp. 113–122, Dec., 1913.)—According to Hindrichs, the zinc-cadmium series shows a simple eutectic with no solubility in the solid, but in studying the hardness of this series, Saposchnikow and Sachorow obtained a complicated curve with two maxima. To clear up this discrepancy the authors have undertaken the study of the hardness and conductivity of these alloys prepared from Kahlbaum's pure metals and annealed at 225° C. for 84 hours. The conductivity of Cd is $\lambda_0 = 14{\cdot}5$ and that of Zn, $\lambda = 18{\cdot}1$, while the conductivity-concentration graph is a straight line. The hardness-concentration curve shows a maximum at the eutectic composition (82·6 % Zn). This was considered to be due to the surface tension and smaller crystallisation obtained in alloys of about the eutectic composition, and accordingly another series of alloys were hammered and annealed for 900 hours at 225° C. to attain the stable state. This series shows that the hardness of the stable alloys is a rectilinear function of the concentration. With a ball of 9·52 mm. diam. under a load of 200 kg., the Brinell hardness of Zn is 38·1, and that of Cd 22·0. F. C. A. H. L.

994. *Researches on Bearing Metals. Antimony-Lead-Tin Alloys.* **E. Heyn** and **O. Bauer.** (Verein. z. Beförd. des Gewerbfleisses, Verh. [235 pp.] 1914. Supplement.)—The general requirements of bearing metals are discussed and a brief description of the Pb-Sb-Sn alloys used in practice (with or without the addition of Cu) is given with reference to their mechanical properties as determined by Charpy. In the Pb-Sb-Sn series a complete study has been made of the liquidus and solidification ranges of the alloys, extended by microscopic examination. The results have been summed up in a ternary model and diagrams showing the isothermals and the division of the liquidus surface into fields of like phases. Slowly-cooled alloys containing below 25 % Sb showed distinct tendencies towards segregation owing to the flotation of the specifically light, cubical Sb-rich crystals. Addition of Sn at first increased this tendency, after which further additions lowered the amount of segregation taking place. In actual practice steps must be taken to prevent this phenomenon by rapid cooling. The hardness of the alloys was found to attain a sharply defined maximum in the neighbourhood of 30 % Sn, 60 % Sb, and 10 % Pb. During the passage from pure Pb-Sb alloys to pure Sn-Sb alloys by gradual addition of tin the hardness first rose, then fell, then attained a second maximum, after which a rapid fall was experienced. Study of the effect of annealing at 150° C. on the hardness of rapidly cooled alloys showed that while the hardness of Sn-rich (over 80 %) alloys was increased, that of the Sn-poor alloys was decreased by this treatment. Resistance to shock compression has been studied by subjecting cylindrical specimens to blows from a falling weight at temperatures of 100°, 20°, and — 20° C. The number of blows required to cause cracking (or fracture in the case of brittle alloys) was counted, and at the same time the decrease in height of the specimen observed. Generally speaking the brittleness of the alloys was found to increase as the hardness increased, but the Sn-rich alloys containing less than 25 % Sb were found to combine considerable hardness with absence of brittleness under shock. Normal compression tests were also carried out and were found to follow closely the ball hardness tests, the Sn-rich alloys showing no anomaly in this respect. The relation between these properties and composition has been summed up in a number of the well-known triangular diagrams which should facilitate the choice of a bearing metal for any particular purpose. A study has also been made of the effect of Cu on these alloys. It has been found that even 2 to 3 % of this element greatly hinders segregation, and has the effect of raising the temperature at which solidification commences, this latter effect being most pronounced in the Pb-rich alloys. Rapidly cooled alloys containing copper were found to be harder and, in the majority of cases, less brittle than slowly cooled alloys of the same composition. It appears, therefore, to be of distinct advantage to effect rapid cooling of such alloys during solidification. The paper contains 35 tables and 233 diagrams in the text and 18 plates of photomicrographs. F. C. A. H. L.

995. *Spontaneous Recalescence of Quenched Steels at* 100° C. **H. Schottky.** (Ferrum, 10. p. 274, 1913. Rev. de Métallurgie, 11. pp. 23–24, Jan., 1914. Extract.)—If a delicate thermometer be placed in a mass of hardened steel heated in a steam bath it is found that the temperature of the steel rises above that of the vapour by some tenths of a degree and falls to the normal value only very slowly. Experiments with a 0·89 % carbon steel indicated that the recalescence increased with the temperature of quenching thus :—

An 89 % carbon steel quenched at	800° C.	1200° C.	1400° C.
Recalescence	0·30	0·35	0·40

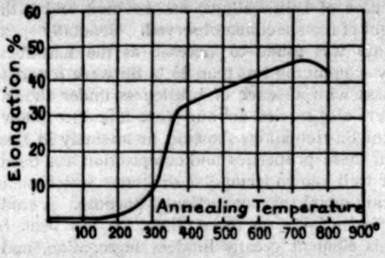
Steels of varying carbon-contents showed the following results :—

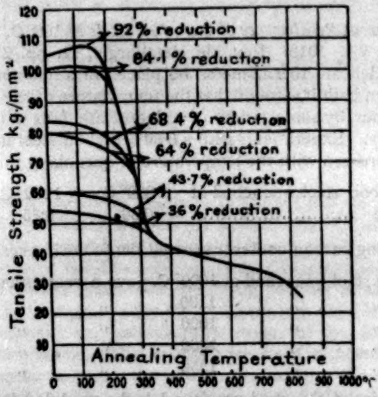
0·54 %	carbon steel	quenched at	1000° C.	gave a	recalescence of	0·15° C.
0·89	„	„	1100	„	„	0·35
1·22	„	„	1000	„	„	0·55
1·43	„	„	1300	„	„	0·33
1·60	„	„	1350	„	„	0·20

Other properties of the steel are found to be modified by this treatment. The change is probably due to the partial conversion of austenite into martensite. F. C. A. H. L.

996. *Influence of Thermal Treatment on the Strength of Drawn Bronze.* **P. Goerens** and **J. Dumont.** (Ferrum, 10. pp. 21–27, 1913. Rev. de Métallurgie, 11. pp. 30–33, Jan., 1914. Extract.)—A systematic study has been made of the effect of thermal treatment on the strength of bronze wires which have been mechanically hardened under known conditions, the reduction of area of the original section being taken as a measure of the degree of

cold-working. Using a bronze containing 94 % Cu and 6 % Sn, two series of tests have been made: one in which annealed wire 6·5 mm. in diam. formed the starting-point, and the other in which annealed wire 4·8 mm. in diam. formed the starting-point. The results are summed up diagrammatically in the accompanying Figs. They show that the increase of strength due to cold work is almost directly proportional to the degree of mechanical hardening. Up to a certain temperature which decreases as the degree of cold work increases, annealing has little effect on the strength and ductility, but between this temperature and 400° C. there is a rapid fall in strength and increase in ductility. Above 750° C. both strength and ductility fall off owing to overheating of the metal. It would appear that the mechanical properties of bronze annealed at temperatures above 815° C. are independent of the previous cold work carried out on the metal and that all mechanical hardening disappears after annealing at this temperature. The time effect in annealing is only observed below 815° C.; at higher temperatures the whole effect is exerted in the first few minutes. The rate of cooling subsequent to annealing is without effect on the mechanical properties. F. C. A. H. L.





997. *Fragility produced in Iron and Steel by Deformation at Different Temperatures.* G. Charpy. (Comptes Rendus, 158. pp. 811–815, Feb. 2,

1914.)—Recent researches have shown that the majority of steels show a max. fragility between 450° and 475° C. and that certain steels become very fragile after being worked at temperatures between 300° and 400° C. The author's work shows that all iron and steels do undergo a diminution of resilience after being worked at temperatures between 0° and 400° C. The decrease appears to attain a maximum at about 250° C.—a temperature corresponding to the max. tensile strength and minimum elongation observed by A. le Chatelier and the maximum of hardness observed by G. Robin. Purity appears to be the determining factor in the degree of reduction of the resilience, pure iron being only very slightly affected. Further, increasing the amount of deformation increases the lowering of the resilience. Tests made on 2 % and 6 % nickel steels show similar phenomena, and, further, indicate that nickel steels are more fragile than the corresponding plain steels.
F. C. A. H. L.

998. *Comparison of the Point at which the Solid State disappears with the Critical Point of a Liquid by means of the ψ-Curve.* **J. D. van der Waals.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 39–40, Sept. 3, 1913.)
T. H. P.

999. *Rusting of Iron in Water.* **W. A. Bradbury.** (Chem. News, 108. pp. 307–308, Dec. 26, 1913.)—Many years ago Crace Calvert came to the conclusion that the rusting of iron in water was brought about by dissolved carbonic acid and oxygen, the former being the predisposing cause since no action occurred in its absence. These conclusions have since been widely supported. Experiments conducted by the author show that rusting takes place very rapidly in tap-water, while in well-boiled tap-water no rusting should occur. During rusting atmospheric oxygen is absorbed. The solution of iron by carbonic acid should result in the production of hydrogen, thus $Fe + 2H_2CO_3 = FeH_2(CO_3)_2 + H_2$, but in experiments with tap-water no gas could be collected over a week. Water saturated with CO_2 did evolve considerable quantities of gas. The experiments confirm the view that rusting is due to the combined action of oxygen and carbonic acid, and show that the oxygen is utilised in two ways: (*a*) in the oxidation of the nascent hydrogen liberated, and (*b*) in the oxidation of bicarbonate of iron to rust. Further tests showed that magnesium chloride solution does not act on iron in the absence of carbonic acid although it has been stated that such solutions do react with iron even in the cold according to the equation—

$$Fe + MgCl_2 + 2H_2O = Mg(OH)_2 + FeCl_2 + H_2.$$

F. C. A. H. L.

1000. *The Porosity of Iron.* **W. H. Perkins.** (Chem. Soc., Journ. 105. pp. 102–106, Jan., 1914.)—The author has repeated and extended Friend's experiments [Abstract No. 408 (1912)] on the absorption of caustic alkalies by samples of iron. Experiments carried out in Pt-dishes with sodium, potassium, barium, lithium, and ammonium hydrates show that distinct traces of alkali are retained by iron and, in fact, other metals. Their extraction is a slow process of diffusion and is not hastened by shaking. F. C. A. H. L.

1001. *Influence of Manganese on the Mechanical Properties of Grey Cast-iron.* **F. Wüst** and **H. Meissner.** (Ferrum, 11. pp. 97–112, Jan. 8, 1914.)—The object of the research has been to determine the upper limit of manganese permissible in grey cast-iron about which a considerable difference of opinion has existed. Four series of irons (I, II, III, and IV) containing about 1·5 % Si, 2·7, 3·0, 3·3, and 3·9 % C respectively and in which the Mn varied from 0·1 to 2·5 %, were prepared and subjected to chemical analysis, bending, tensile, impact, and hardness tests and microscopic examination. Chemical analysis showed that the phosphorus and sulphur were low (below 0·03 and 0·01 % respectively) and that the graphite increased with increase of total carbon. Below 0·3 %, increase of Mn increases the tendency towards graphite formation, but between 0·3 and 2·5 % the Mn exerts no further influence on the form in which the carbon separates. The bending and tensile strengths of series I and II attain a maximum in the region of 1 % Mn. In series I, II and III the deflection during bending and the impact strength are first improved and then diminished by increasing Mn; hardness is steadily increased. In every case the worst mechanical properties are exhibited by the high-carbon alloys and the best properties are possessed by those alloys containing about 3 % carbon. Microscopic examination indicates that by increasing the amount of primary crystallisation, Mn decreases the solidification interval, and increases the stresses set up by the deposited graphite. This accounts for the weakening effect of high manganese additions. High carbon acts contrariwise by increasing the quantity of eutectic. Increasing Mn decreases the size of the graphite particles and the ferrite areas and renders the pearlitic structure much finer in character.

F. C. A. H. L.

1002. *Transformation-points and Structure of Nickel-Chrome Steels.* **L. Guillet.** (Comptes Rendus, 158. pp. 412–414, Feb. 9, 1914.)—The work described in Abstract No. 1550 (1913) has been continued, and a study made of the critical points, microstructures, resilience, and ball hardness of two series of low-carbon steels containing 2 % and 4 % nickel respectively and increasing amounts of Cr. In both series Cr decreases the resilience and increases the hardness, while the effect on the transformation points is summed up in the following table:—

2 % Nickel Steels.			4 % Nickel Steels.		
Cr %.	Ac °C.	Ar °C.	Cr %.	Ac °C.	Ar °C.
0·06	670	640	0	655–725	680–550
0·90	705	615	0·95	700	425
1·00	700	590	1·90	700	360
1·99	715	430	3·05	705	250
3·00	715	350	5·35	715	230
4·84	730	240	8·26	715	abt. 200
5·29	720	230	13·87	715	invisible
7·17	715	210			
10·25	720	invisible			

The lowering of the critical point is not directly proportional to the Cr-content and in the 4 % nickel series the lowering due to small proportions of Cr is greater than in the 4 % series. The steels may be classified into three groups: (1) Pearlitic steels in which the transformation-point on cooling is not more than 125 deg. C. lower than that on heating; (2) martensitic steels commencing with those in which the critical point on cooling is at about 350° C.; and (3) steels containing free carbide when the critical point on cooling is below 230° C. In the latter group the whole of the Cr is not held in solution, while the second group forms the class of air-hardening steels.

F. C. A. H. L.

1003. *Critical Ranges A2 and A3 of Pure Iron.* **G. K. Burgess** and **J. J. Crowe.** (Bureau of Standards, Bull. 10. pp. 315–368, 1914.)—An elaborate and detailed description of the apparatus used and methods employed in carrying out the research work dealt with preliminarily in Abstract No. 1540 (1913). The final results indicate that A*c*2 and A*r*2 occur at 768° ± 0·5, while A*c*3 occurs at 909° ± 1 and A*r*3 at 898° ± 2. F. C. A. H. L.

1004. *A New Etching Agent for Steel.* **W. Rosenhain.** (Nature, 92. p. 529, Jan. 8, 1914.)—In conjunction with J. L. Haughton, the author has found that the acid solution of ferric chloride, frequently employed for etching copper alloys, containing about 0·1 % cupric chloride and 0·05 % stannic chloride is a most useful reagent in the microscopic analysis of steels. The ferrite in ordinary carbon steels is blackened, while pearlite and cementite remain white. In commercial steels the ferrite is not darkened uniformly, but appears to assume a banded structure. Copper appears to be deposited with the greatest rapidity on pure ferrite. Phosphorus exerts a considerable retarding action and the reagent is capable of indicating the distribution of phosphorus in a manner quite as striking and in much less time than is required by the process of heat-tinting. F. C. A. H. L.

1005. *Flame Reactions.* I. **W. D. Bancroft** and **H. B. Weiser.** (Journ. Phys. Chem. 18. pp. 213–263, March, 1914.)—While it is generally agreed that free metallic vapours exist in flames, there are differences of opinion respecting the way in which the metals are set free. No independent proof of the occurrence of free metals in flames has been given except in two separate cases studied by Salet and Smithells respectively. The authors have made a number of experiments in this direction, with the following results. At the temperature of the Bunsen flame many metallic salts are dissociated and the metal liberated, while in the oxy-hydrogen flame still more salts are similarly decomposed. The presence of free metallic vapours in a flame can often be shown by condensing the metals on a chilled porcelain tube. By precipitation from the Bunsen flame it has been found possible to prepare metallic mirrors of copper, cadmium, tin, silver, lead, bismuth, zinc, arsenic, and antimony, and to obtain mercury in the form of drops; from the oxy-hydrogen flame mirrors of molybdenum and tungsten have been prepared. Sulphur can be precipitated from the hydrogen-air flame containing SO_2 and, also, mixed with carbonaceous matter, from a Bunsen flame containing SO_2. Red phosphorus can be precipitated from a hydrogen-air flame fed with phosphorus trichloride, and it seems probable that metallic sodium and potassium have been precipitated from oxy-hydrogen flames fed with sodium and potassium chlorides, but since these metals oxidise at once, the proof of their precipitation is not conclusive. The principle underlying the experimental results is that all exothermal compounds must decompose if at a sufficiently high temperature; the reducing action of the flame gases is not essential, although it may at times increase the decomposition. In the hydrogen-chlorine flame the dissociation of chlorides is retarded. When phosphorus burns relatively slowly, the flame is green just as when a phosphorus compound is added to a cooled Bunsen flame. T. H. P.

1006. *On Gelatinous Structures.* **R. Zsigmondy.** (Phys. Zeitschr. 14. pp. 1098–1105, Nov. 15, 1913. Paper read before the 85. Naturforscher-versamml., Wien.)—Discusses the two main theories of gels: the honeycomb theory, according to which gels consist of minute elastic solid chambers including liquid; and the microcrystalline theory. Shows that both forms are extant. In the case of silica gels the porous character is proved by the reduction of vapour pressure of liquids absorbed by the gel, which again is due to the occurrence of numberless concave menisci. In the case of gelatine, the pores close on drying, so that other methods must be found for demonstrating the porous structure. The gelatinisation of soap solutions, barium malorate, congo red, and other substances is due to the formation of a microcrystalline felt. E. E. F.

1007. *Distribution of a Colloidally Dissolved Substance over Two Layers.* **W. Reinders.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 379–385, Nov. 27, 1913.)—When three non-miscible liquids meet, two cases present themselves: (1) when none of the three contact surface tensions is greater than the sum of the other two, the three phases meet in one common side; (2) when, for instance, $\sigma_{1,2}$ is greater than $\sigma_{2,3} + \sigma_{3,1}$, 3 will expand between 1 and 2 and prevent contact between them. If one of the three phases is solid, the same two cases are distinguishable, except that in the latter, phase 3 arrives at the surface of contact of 1 and 2. Further, if phase 3 is suspended in the liquid 1 as a fine powder and this suspension shaken with liquid 2, one of three things may occur: (*a*) If $\sigma_{2,3}$ is greater than $\sigma_{1,2} + \sigma_{1,3}$, 3 will be completely enveloped by 1, in which the suspension thus remains unchanged; (*b*) if $\sigma_{1,3}$ is greater than $\sigma_{1,2} + \sigma_{2,3}$, the stable condition will be such that 3 is completely enveloped by 2, so that the suspension passes entirely from 1 to 2; (*c*) if $\sigma_{1,2}$ is greater than $\sigma_{2,3} + \sigma_{31}$, or if none of the three contact surface tensions is greater than the sum of the other two, the powder is deposited entirely on the surface of contact. In the case of a suspensoid in which solid floating particles are present, when these are fairly large and practically of uniform dimension, the surface tension in regard to the surrounding medium may be assumed to be but slightly dependent on this dimension, and hence the same for all the particles; the above three possibilities consequently apply here also. As the particles diminish in size, the resultant of the molecular attractions which appears as surface tension becomes dependent in high degree on the number of molecules together forming the particle. It will then be possible for particles below a certain size to pass into the second liquid and for larger ones either to arrive at the surface of contact or to remain in the first liquid. Finally, if the colloidal particles each consist of only a few molecules, the ideas of surface and of surface tension lose their significance; the solution is then an ordinary molecular one and the dissolved substance will distribute itself throughout the two liquids according to the law of distribution, factors other than surface tension then dominating the distribution. Complications may here arise owing to the union of the particles deposited at the surface of contact to larger coagulums, this happening readily with unstable solutions. With emulsoids or solutions in which the presence of floating liquid droplets must be assumed, these, if deposited at the surface of contact, may unite to form a separate liquid layer when $\sigma_{1,2}$ is greater than $\sigma_{2,3} + \sigma_{3,1}$. If, however, the separation at this surface has taken place because none of the three surface tensions was greater than the sum of the other two, the expansion of liquid 3 between 1 and 2 becomes impossible, and the isolated droplets of 3 will unite with greater difficulty.

In order to investigate these considerations experimentally, the author has examined the behaviour of several different colloidal solutions towards a second liquid. The results obtained show that case (*b*)—separation at the surface of contact—is a very common one, instances of the other two cases being also found ; case (*b*) is, indeed, so common that it will often be possible to determine the colloidal nature of a solution by exhibiting the separation at the surface of contact on shaking with a second liquid. The above cases refer to non-reversible or only partially reversible colloids. With typically reversible colloids such as gelatine, such separation at the limiting surface has also been observed, and this reaction has even been utilised for demonstrating the presence of these substances in a solution ; in most cases, however, the total quantity deposited appears to be small. This adhesion to the surface of contact with a second liquid is, moreover, quite comparable with the surface adhesion of an added solid substance, as has been often observed with colloidal solutions. T. H. P.

1008. *Amalgams containing Silver and Tin.* **W. A. Knight** and **R. A. Joyner.** (Chem. Soc., Journ. 103. pp. 2247–2262, Dec., 1913.)—The authors have made a study of the equilibria of amalgams containing silver and tin, and have also studied further the question of ageing [cf. Abstract No. 965 (1911)]. It has been found that the equilibrium diagrams, which have been carried up to 214°, can be grouped into two classes—those above about 70° containing a large proportion of solid solution and those below only negligible amounts. A. F.

1009. *Properties of Liquids as Functions of the Critical Constants.* **J. Kendall.** (Medd. K. Vet. Nobelinstitut, 2. No. 29. pp. 1–28, 1913.)—The author derives the following expressions, which are found to agree with Young's experimental results [see Abstract No. 1785 (1910)] over the ordinary range of temperatures, (1) $Q = k(T_c - T)^n$, where Q is the latent heat of vaporisation, T and T_c are the temperature and critical temperature respectively, *k* is a constant characteristic of the particular liquid, and *n* a constant of the value 0·886, for all normal liquids. This formula and Trouton's rule together give the expression, $MQ = 20{\cdot}7\,T(1 - T/T_c)^n$, M being the molecular weight. (2) $\sqrt[3]{d} - \sqrt[3]{d_c} = k_1(T_c - T)^{\frac{1}{3}}$, in which *d* is the density of the liquid at T°, d_c the critical density, and k_1 a constant varying with the nature of the liquid. Further, $\sqrt[3]{d_c} - \sqrt[3]{D_c} = k_2(T_c - T)^{\frac{1}{3}}$, where D represents the density of the saturated vapour at T and k_2 is a constant for any particular substance.

The densities of liquids at absolute zero temperature, calculated from the above equations, agree well with Guldberg's extrapolated results. With all normal liquids, the ratio between the densities at absolute zero and at the critical temperature is approximately 3·75, the value given by Guldberg. Equation (2) thus takes the form $\sqrt[3]{d/d_c} - 1 = 0{\cdot}553(1 - T/T_c)^{\frac{1}{3}}$, which is in fairly good agreement with the results obtained for normal liquids. The above equations, in conjunction with that of Mills for the heat of vaporisation, lead to the expression (3) $Q = 0{\cdot}000031833\,P(V - v) + k_1\mu(T_c - T)^{\frac{1}{3}} + k_2\mu(T_c - T)^{\frac{1}{3}}$, P being the vapour pressure, V and *v* the volumes of 1 gm. of the saturated vapour and the liquid respectively and μ a constant for any particular compound. It will be seen that equation (1) is an interpolation formula, the exponent, 0·886, being intermediate to those of the second and third terms of the right-hand side of equation (3). The latter takes the form, $Q = RT/M + k_1\mu(T_c - T)^{\frac{1}{3}} + \mu\sqrt[3]{d_c}$ for low temperatures, and in this the condition $dQ_0/dT = 0$ is satisfied if $k_1\mu M/3T_c^{\frac{2}{3}} = R$, which is the case with normal liquids. T. H. P.

1010. *Electrical Conductivity in Hydrocarbons and their Halogen-derivatives, in Esters, and in Bases as Solvents.* I. and II. **P. Walden.** (Acad. Sci. St.

Petersburg, Bull. No. 16. pp. 907–936, Nov. 15, and No. 17. pp. 987–996, Dec. 1, 1913.)—I. For investigating electrolytic conduction in inert solvents, tetra-*iso*-amylammonium iodide, $N(C_5H_{11})_4I$, has been found to be a specially suitable solute. Measurements have been made of the conductivity of this and of similar salts in—

Methylene chloride CH_2Cl_2
Chloroform $CHCl_3$
Carbon tetrachloride CCl_4
Ethylene chloride $C_2H_4Cl_2$
Acetylene tetrachloride $C_2H_2Cl_4$
Propyl chloride C_3H_7Cl
Allyl chloride C_3H_5Cl
Ethyl bromide C_2H_5Br
Acetylene tetrabromide $C_2H_2Br_4$
Methyl iodide CH_3I
Carbon disulphide CS_2
Benzene C_6H_6
Toluene $C_6H_5 . CH_3$
Benzyl chloride $C_6H_5 . CH_2Cl$

The molecular conductivities were always small, only rarely rising to 15 units and often falling almost to zero. In many cases they showed the maxima and minima, which are characteristic of salts dissolved in solvents of relatively small ionising power, and which have been attributed to the development of "autolytic conductivity," (compare fused salts) in concentrated solutions.

II. Measurements were also made in the following solvents:—

Aniline $C_6H_5 . NH_2$
Quinoline C_9H_7N
Methylaniline $C_6H_5 . NH(CH_3)$
Sulphurylchloride SO_2Cl_2
Acetic Acid $CH_3CO . OH$
Ethyl formate $H . CO . OC_2H_5$
Methylacetate $CH_3CO . OCH_3$
Methyl benzoate $C_6H_5 . CO . OCH_3$

The general results are summarised as follows:—All solvents, starting with benzene, toluene and chlorinated hydrocarbons (for which the dielectric constant $\epsilon = 2{\cdot}2 - 2{\cdot}8$) give conducting solutions. The conductivity depends (1) on the nature of the electrolyte, binary salts being the best, (2) on the concentration, since concentrated solutions in these feebly-ionising solvents give marked conductivity. On diluting, the molecular conductivity may (1) rise to a maximum and then fall rapidly without reaching a minimum, (2) rise to a maximum, fall to a minimum and then rise again, (3) rise continuously, without passing through a maximum or minimum. For a given salt, *e.g.* $N(C_5H_{11})_4I$ or $N(C_3H_7)_4I$, type (1) is found when $\epsilon = 2$, type (2) when $\epsilon = 4{\cdot}95$ (chloroform) to 8—9—10 (CH_2Cl_2, C_2H_5Br, C_9H_7N, $C_2H_4Cl_2$) and type (3) when $\epsilon > 9$ or 10. Salts with less ionising tendency, *e.g.* $N(C_3H_7)_3, HCl$, may, however, give maxima and minima in solvents of dielectric constant higher than 9.

It is further noted that (1) in solvents of equal viscosity, the molecular conductivity increases with the dielectric-constant ϵ of the solvent; (2) in solvents of equal dielectric constant, the conductivity increases as the viscosity decreases or as the fluidity f increases; (3) therefore the conductivity at a given dilution is a function of the dielectric constant and the fluidity of the solvent $\lambda_v = F(\epsilon, f)$.

Similar statements apply to the conductivity at the minimum-point (observed in solvents for which $\epsilon < 9$), the conductivity increasing with the dielectric constant and with the fluidity, until the growth of ϵ causes the minimum to vanish. T. M. L.

1011. *Calculation of the Electrical Conductivity in very Dilute Aqueous Solutions.* **S. Arrhenius.** (Medd. K. Vet. Nobelinstitut, 2. No. 42. pp. 1–12, 1913.)—Assuming that the conductivity of water is due to carbonic acid, the methods usually adopted for correcting the conductivity of solutions of acids and salts for the influence of the solvent are justified theoretically where the salts are those of strong acids or the acids are stronger than acetic acid. With salts of weak acids the theoretical correction is less than that corresponding with the conductivity of the solvent, and depends, as a first approximation, on the ratio of the ionisation-coefficient, k, of the acid to the concentration, c, of the salt. The values of the relation between the actual correction and the conductivity of the solvent are given for a series of values of k/c. With very dilute solutions of sodium chloride and nitrate, the variation of the conductivity is in agreement with the requirements of the law of mass action, and this is probably the case with all electrolytes at sufficiently high dilutions. T. H. P.

1012. *The Drop-weights of Aqueous Solutions of the Salts of Organic Acids.* **J. L. R. Morgan and W. W. McKirahan.** XIV. (Amer. Chem. Soc., Journ. 35. pp. 1759–1766, Nov., 1913.)

1013. *The Weight of a Falling Drop and the Laws of Tate.* XV. *Drop-weights of Certain Organic Liquids and the Surface Tensions and Capillary Constants calculated from them.* **J. L. R. Morgan** and **P. M. Chazal.** (Amer. Chem. Soc., Journ. 35. pp. 1821–1834, Dec., 1913.)—Twenty-five organic liquids were studied, of which nine (benzonitrile, *o*-, *m*- and *p*-toluonitriles, hexane, ethyl mercaptan, thiophenol, phenyl isothiocyanate, and ethyl acetoacetate) were found to be non-associated, and sixteen (ethyl isothiocyanate, allyl isothiocyanate, methyl malonate, ethyl malonate, ethyl dimethyl acetoacetate, ethyl diethyl acetoacetate, ethyl oxalate, acetonitrile, butyronitrile, valeronitrile, acetyl acetone, methyl cinnamate, ethyl cinnamate, phenyl hydrazine, monoacetin, amyl succinate) were found to be associated. The authors' results are, in some cases, in harmony with, in other cases divergent from, those of other workers. In the case of the toluonitriles the order of the surface tensions is ortho-, para- and meta-, the latter having the lowest surface tension, although the usual order is ortho-, meta-, para-. The authors consider that the conclusions of Schenck and Ellenberger that acetyl acetone and ethyl acetoacetate are tautomeric mixtures is not justified. A. F.

1014. *The Weight of a Falling Drop and the Laws of Tate.* XVI. *Drop-weights of Certain Organic Liquids and the Surface Tensions and Capillary Constants calculated from them.* **J. L. R. Morgan** and **B. J. Kramer.** (Amer. Chem. Soc., Journ. 35. pp. 1834–1845, Dec., 1913.)—The surface tensions of twenty-four organic liquids have been determined at different temperatures, and the temperature equations calculated. On the whole, good agreement with the results of other investigators was found. A. F.

1015. *The Weight of a Falling Drop and the Laws of Tate.* XVII. *Drop-weights and Surface Tensions of Molten Hydrated Salts and their Solutions.* **J. L. R. Morgan** and **E. Schramm.** (Amer. Chem. Soc., Journ. 35. pp. 1845–1856, Dec., 1913.)—Drop-weights have been determined and surface tensions calculated for thirty-two concentrations of calcium chloride in water solution, for 16 of zinc nitrate, for 14 of sodium chromate, and for 15 of sodium thiosulphate. It was found that supersaturated solutions behave, with respect to surface tension, exactly as ordinary ones do. The relationship between surface tension and concentration was in all cases found to be curvilinear and convex to the concentration axis. No change in curvature which would indicate the presence of any hydrate in solution was found in the curves. Valson's relationship, that salt solutions of equivalent concentration possess the same surface tension, was shown to be only approximately (5–6 %) true. Heydweiller's relationship connecting surface tension with the number of equivalents present and the ionisation was found in harmony with experiments only in some cases. A. F.

1016. *The Weight of a Falling Drop and the Laws of Tate.* XVIII. *Drop-weights, Surface Tensions, and Capillary Constants of Aqueous Solutions of Ethyl, Methyl, and Amyl Alcohols, and of Acetic and Formic Acid.* **J. L. R. Morgan** and **M. Neidle.** (Amer. Chem. Soc., Journ. 35. pp. 1856–1865, Dec., 1913.)—In connection with the above measurements, the very large effect of even minute amounts of amyl alcohol on the surface tension of water is shown. The relationship of Duclaux that for aqueous solutions of homologous alcohols and acids the ratio of the concentrations of any two homologues in the solutions exhibiting the same surface tensions is constant, is confirmed. Evidence of mutual disassociation of liquids is not obtained. Associated liquids, when mixed, do not give for the mixture a surface tension equal to the mean of the two constituent surface tensions. A. F.

1017. *Solutions of Radio-active Products.* **T. Godlewski.** (Le Radium, 10. pp. 250–264, Aug., 1913. Paper read before the Acad. of Sciences, Cracovie, June, 1913.)—A solution of RaEm and its products in pure water was taken and electrolysed by a few milliamps. for about 90 secs. The anode was found to be activated with RaA and about 1/3 of its equilibrium amount of RaC. The kathode was found to be activated with RaB, and about 1/4 its equilibrium amount of RaC. The same results were obtained when the RaEm was first removed by bubbling, and only the active deposit particles were left; so that the charges on the atoms at the moment of their creation are not the determining factor. The magnitude of the e.m.f. used was shown to determine the speed of electrolysis but not the relative proportion of the products delivered to the anode or kathode. The author concludes that the radioatoms are not present in the solution as ions but as colloidal hydrosols, the RaA atoms constituting negative granules and the RaB positive, while those of RaC are either positive or negative. This hypothesis is verified by adding various electrolytes, such as HCl, $Al_2(SO_4)_3$, NH_4OH, $K_3C_6H_5O_7$, etc., the resulting distribution of the products at anode and kathode being always such as could be predicted from the known actions of these substances on colloids. For instance, the hydrogen ions from HCl diminish the number of negative suspensions, and increase the number of positive. By suitable concentration of various electrolytes it is shown that it is possible to vary the ratio of the anode and kathode activities by 1 : 40000. E. M.

1018. *The Occurrence of an Upper Critical Point of Mixing and the Coexistence of Two Mixed Crystal Phases.* **A. Smits** and **C. A. L. de Bruyn.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 557–564, Dec. 27, 1913.)—When a fused mixture of KCl and NaCl is suddenly cooled the resulting solid mass has different properties (heat of solution, etc.) from that obtained on slow cooling. The authors have investigated this more fully, and they find that the mixed crystals of KCl–NaCl break up on slow cooling into two sets of mixed crystals, the composition of which depends on the temperature. In other words, there is a partial miscibility for KCl–NaCl in the solid state, and this curve exhibits a maximum point, beyond which there is complete miscibility, at a temperature of 407°, the composition at the solution at this temperature being 66·6 moles per cent. of NaCl. A. F.

1019. *Equation of State, Diagram of State, and Association Hypothesis.* **L. Schames.** (Deutsch. Phys. Gesell., Verh. 15. 20. pp. 1017–1026, Oct. 30, 1913. Paper read before the Deutsch. Naturforscherversamml., Sept., 1913. Phys. Zeitschr. 14. pp. 1172–1175, Nov. 15, 1913.)—The author discusses the diagram of state deduced on the basis of the association hypothesis [Abstract No. 1858 (1912)]. This reduced equation of state takes the form—

$$\left(\omega\frac{c}{c_k}-\frac{1}{3}\right)\left(\pi+\frac{3}{\omega^2\theta}\,\frac{c-1}{c_k-1}\right)=\frac{8}{3}\,\theta,$$

and does not exhibit the disagreement with experiments such as is shown by van der Waals' equation. From this equation, also, one is led to the assumption of an ideal liquid for which van der Waals' equation of vapour pressure would be accurate. This latter equation gives a condition of existence of the true liquid state and leads to a modification of the diagram of state, which in turn points to the existence of a second critical point for liquid-solid in the case of normal substances, including water under very high pressures. A. F.

1020. *Critical State and the Theory of Continuity.* **I. Traube.** (Deutsch. Phys. Gesell., Verh. 15. 22. pp. 1219–1234, Nov. 30, 1913.)—Unsuitable for abstracting.

1021. *Viscosity of Calcium Chloride Solutions.* **F. Simeon.** (Phil. Mag. 27. pp. 95–100, Jan., 1914.)—The results are given in the form of tables, and compared with those of Tucker by means of curves. L. H. W.

1022. *Thermal Calculation of Electromotive Forces.* **J. N. Brönsted.** (Zeitschr. Elektrochem. 19. pp. 754–757, Oct. 1, 1913.)—The calculations concern the silver chloride/calomel and the lead chloride/calomel cells. The heat of reaction $Hg + AgCl \longrightarrow Ag + HgCl$ is 1420 cals. according to the author's recent, and 1400 to his previous measurements ; the heat of reaction $\frac{1}{2}Pb + HgCl \longrightarrow Hg + \frac{1}{2}PbCl_2$ is similarly 10,730 cals. (11,000 previous value). Pollitzer's values for the two reactions, 550 and 11,740 cals., are incorrect, and Pollitzer is criticised by the author, who calculates by Nernst's theorem e.m.f.'s of 0·026 and 0·514 (against 0·028 and 0·521 observed) volt for the two cells at the temperature T = 234°. In these calculations the recent valuations of Nernst and Lindenmann for the specific heads are adopted. H. B.

1023. *Potential-drops at the Boundary between Liquid and Gas.* **L. v. Putnoky.** (Zeitschr. Elektrochem. 19. pp. 920–923, Dec. 1, 1913.)—Quincke observed in 1860 that gas-bubbles migrate in water towards the positive pole, like suspended solid particles. The author shows theoretically that the potential liquid/gas should be deducible from the rates at which gas-bubbles rise in the space between the electrodes of an electric field when this field is excited or not. The experimental verification of the formula with the aid of electrodes of palladium and air-bubbles in water (pure or saturated with camphor) were unsatisfactory, however, because the bubbles began to oscillate when the field was turned on ; yet the experiments show the existence of the effect. It is described how bubbles can be liberated from a capillary at regular intervals. H. B.

1024. *Application of the Theory of Allotropy to Electromotive Equilibria.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 699–710, Jan. 29, 1914.)—The author applies the theory of allotropy to the electromotive equilibrium between a metal and an electrolyte, in which it appeared that a metal exhibiting the phenomenon of allotropy, and consequently composed of molecules differing in their degree of association, will emit, when immersed in an electrolyte, ions of different kinds [see Abstract No. 1279 (1912)]. It is demonstrated that the "unary" electromotive equilibrium belongs to the Δ, x-figure of a pseudo-system, which may be realised for the case when the molecules and ions of the metal are not interconvertible, *e.g.* in presence of a negative catalyst.

Application of this view to the phenomenon of electrolysis leads to the following results. Firstly, it is made clear that, and why, in many cases of electrolytic deposition of metal, the metastable and not the stable phase will be obtained. Secondly, the theory shows that, when the internal transformations under negative catalytic influences fail to appear or are impeded, the metal that is made to dissolve electrolytically will get less base superficially, whereas the freshly deposited metal will be baser than that passing into solution. Next, it is rendered probable that the periodic oscillations in the p.d., which point to a periodic ennobling of the metal surface, may be accounted for from the same point of view. It is further demonstrated why the contact of a metal with a solution of one of its salts must exert an accelerating influence on the establishment of the internal equilibrium of the metal. Finally, attention is drawn to the possibility that on reduction of metallic compounds at low temperatures, masses of metal are obtained which are far removed from the condition of internal equilibrium and can exhibit abnormally great chemical activity; this will be the case when they differ from the ordinary metallic states by a greater content of the more simple molecules. The pyrophoric state is perhaps explainable in this way.

T. H. P.

1025. *A New Hydrogen Electrode and its Applicability.* **E. Wilke.** (Zeitschr. Elektrochem. 19. p. 857; Discussion, pp. 857–858, Nov. 1, 1913.)—The ordinary hydrogen electrode being unsuitable for working in viscous fluids like blood serum, in which the gas diffusion is very slow, the author forces hydrogen under pressure into a thin-walled palladium capillary through which it diffuses; Madelung had already used such capillaries for other purposes. This electrode keeps constant against a calomel electrode for weeks and can then be brought back to its former activity (which seems to be impaired when hydrocarbons and fats penetrate into it) by being heated in oxygen. The potential depends upon the pressure quotient inside and outside; varying the inner pressure by 100 atmos., the potential changed by 60 millivolts. The presence of other gases, hydrogen, CO_2, even oxygen, outside the capillary seems to have little influence. **F. Auerbach** and **F. Krüger** pointed out during the *discussion* that, since the pressure of the hydrogen on the outer surface was not well defined, the e.m.f. of the electrode could not be definite and constant.

H. B.